

封面格式

行政院及所屬各機關出國報告
(出國類別：計畫出國(考察))

『考察美國 Hitco、Richmond 公司及收集匿蹤設計應用技術資訊』

服務機關：中山科學研究院 第一研究所

出國人職稱：聘用技士 少校技士

姓名：李啟建 林俊雄

出國地區：美國 加州 洛杉磯

出國期間：91年12月16日至91年12月21日

報告日期：92年1月30日

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國外公差報告

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報告名稱:

考察美國Hitco、Richmond公司及收集匿蹤設計應用技術
資訊

主辦機關:

國防部中山科學研究院

聯絡人/電話:

/

出國人員:

李啓建	國防部中山科學研究院	第一研究所	聘用技士
林俊雄	國防部中山科學研究院	第一研究所	少校技士

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關鍵詞: 匿蹤

內容摘要:

爲因應本院執行「廬山計畫」國防研發案工作之需要，擬赴美國參訪加州Hitco Composite Inc.公司、Richmond Aircraft Product Inc.公司，考察並收集相關科技資訊，以評估前述研發案工程精進之研改技術之可行性。由於空防在制敵先機的戰略上有者舉足輕重要的地位，尤其是空戰已演進爲視距外的作戰模式，波灣戰役成功的運用匿蹤技術即是最佳的明證，考量研發新一代的戰機需要巨額經費，但是運用匿蹤技術研改現有的戰機，經費卻相對地大幅減少，已使得各先進國家皆爭相研發並推廣運用其相關武器系統上，因此本院的「廬山計畫」將更爲重要。Hitco Composite Inc.公司、Richmond Aircraft

Product Inc.公司於匿蹤相關技術均有成熟之技術經驗，
可提供「廬山計畫」相關技術精進與能量建立之參考。

本文電子檔已上傳至出國報告資訊網

壹、 出國目的及緣由

為因應本院執行「廬山計畫」國防研發案工作之需要，擬赴美國參訪加州 Hitco Composite Inc.公司、Richmond Aircraft Product Inc.公司，考察並收集相關科技資訊，以評估前述研發案工程精進之研改技術之可行性。由於空防在制敵先機的戰略上有者舉足輕重要的地位，尤其是空戰已演進為視距外的作戰模式，波灣戰役成功的運用匿蹤技術即是最佳的明證，考量研發新一代的戰機需要巨額經費，但是運用匿蹤技術研改現有的戰機，經費卻相對地大幅減少，已使得各先進國家皆爭相研發並推廣運用其相關武器系統上，因此本院的「廬山計畫」將更為重要。Hitco Composite Inc.公司、Richmond Aircraft Product Inc.公司於匿蹤相關技術均有成熟之技術經驗，可提供「廬山計畫」相關技術精進與能量建立之參考。

任務內容：

- (一) 考察 Hitco Composite Inc.公司，瞭解討論戰機風擋、座艙罩設計、材料、製造成型的新技術，透明導電膜濺鍍技術的新技術。
- (二) 考察 Richmond Aircraft Product Inc.公司，瞭解戰機風擋、座艙罩光學檢驗的規範與新技術，航空用導電塑化材料檢驗需求。

工作目標：

- (一) 瞭解最新吸波材料設計、測試與應用技術，及相關裝備能量。
- (二) 瞭解透明導電膜濺鍍與應用技術，及相關量測能量。
- (三) 蒐集透明導電膜量測檢驗技術相關資料。
- (四) 瞭解戰機風擋、座艙罩外形與結構匿蹤設計及相關應用技術。

貳、 公差心得

參訪 Hitco Composite Inc. 公司

1. Hitco 公司原是研發複合材料的，對於複材結構設計與組裝有多年的經驗，尤其是大型的結構體與耐高溫結構體如 C-17 機尾結構、Delta IV 噴嘴等，其相關的製程設備也有規劃與設計，經營的業務繁多，大致上可區分為材料、結構、應用、製造、研發等方向，這些項目也是吾等關切的重點。
2. Hitco 公司近年與軍方有合作計劃在執行，在有限度的許可下，諮詢與「廬山計畫」有關的技術，材料方面是具有吸波特性的材料，材料的應用提供一般性的介紹，材料本身的設計是礙於機密性沒有任何的意見，參觀吸波材料樣品。
3. 針對飛機結構的應用方面，Hitco 公司使用吸波材料於結構體，這與本院使用的方式相似，依據量測資料分析，將吸波材料貼覆於結構體上，其施工製程是基於 Hitco 公司本身複材疊層的技術運用，確保貼覆品質。
4. Hitco 公司通過 ISO 90001、D1-9000 與 AS 9100 的品質認證，文件與規範是得到空軍與聯邦航署的認證許可，因此產品的可信度是肯定的。
5. Hitco 公司對於電鍍技術是從事碳纖複材表面特殊鍍層加工、陶瓷表面耐摩鍍層與金屬表面耐熱度層等，對於透明導電膜濺鍍技術是語待保留，其實與軍方有研發合作案的關係，不能多談，但是提供意見是要考慮成本與效益，製程技術本身的問題並不是關鍵所在，材料設計與透明度是重點。
6. CAD/CAM 設備，Hitco 公司主要使用 CATIA 與

FiberSim，前者與本所使用的 CAD 軟體相同，後者是處理複材疊層展開的軟體，這對於風擋的匿蹤設計上，使用於貼覆膠膜外形邊界切割有關，故貼覆平順化，就必需要風擋外形設計上能平順展開，Hitco 公司在這方面是有獨到之處，值得學習與效法。

7. Hitco 公司表示願與本所合作，也期待有機會與本所技術交流。
8. Hitco 公司的 ERP 系統是整合研發資料與產品的管理機制，其資訊知識管理的作為有考慮機密等級，公司內可上網查詢，對外而言是公司的能量介紹，資料是嚴格控管的，其保密系統可參考。

參訪 Richmond Aircraft Product Inc. 公司

1. Richmond 公司在膠膜的研發工作已有多年的經驗，且有具體的成果，開發的產品非常廣泛，不僅是航太產業，其他有關製造密封成形的加工，均使用此類產品，因為廬山計畫在製程上用到此類材料，故在加工製程的理念可以交流與吸取經驗。
2. Richmond 公司的研發理念有一特色，主要是材料的開發，依據客戶的需求設計材料，一般而言能掌握材料特性，大致上就沒有問題，但是要能降低持本增加利潤，就要產量大，因此 Richmond 公司也投入應用的研發上，目前在航太產業應用較廣，才與美國軍方合作涉入匿蹤領域。
3. Richmond 公司的密封膠膜產品是多樣性的，在高溫、高壓、一體成形、多層機板、高延展、透氣性等加工環境與物理特性要求下，均能保持材料的穩定性與成品的可靠度，參與波音 (Boeing) 新客機機翼的製造計畫、塞考斯基 (Sikorsky) 旋翼與風擋的製造工作、美國太空總署 (NACA) 燃料桶的製造材料、軍方 F-18、F-117、

F-22 等多項計畫。

4. 本院關切的匿蹤技術是機密性與敏感性，Richmond 公司礙於軍方的保密規定也不便多談，僅對於提出的問題，回答出一般性的論述，但是肯定本院的努力。
5. 由於參與塞考斯基（Sikorsky）的計畫，Richmond 公司對於風擋的研發製程也有一些經驗，本院與塞考斯基（Sikorsky）也有合作的經驗，當時風擋的製程是使用金屬模具成形，成本很高，Richmond 公司是使用密封膠膜成形，通過光學品保的檢驗，是一成功的技術，值得我們考量運用在風擋的匿蹤技術上。
6. 對於航空用導電塑化材料，Richmond 公司表示，此項技術也是參與軍方的計畫，才培養的研發能力，仍在努力中，同樣是礙於軍方的保密規定不便多談。
7. 於洛杉磯的 Richmond 公司是負責產銷的總部，它的製造研發位於賓州，時間有限，不能前往參訪是一憾事。
8. 整體而言，Richmond 公司提供製造的寶貴意見，對於本院匿蹤研改確有幫助，尤其是已服役的戰機，要在不干擾戰機系統結構下施工製程，運用其技術確有幫助，同時其研發的精神亦是值得學習與努力的。

參、 效益分析

藉由參訪收集吸波材料設計技術與透明導電膜濺鍍技術等相關專題資料與案例研討，與國外專家交流資訊，可獲得該等技術之研發動態、技術發展及最新技術資料，以奠定戰機匿蹤研改相關技術知識，同時對於複材結構的設計與材料的研發方向也有交流，可作為爾後計畫研發目標與方向之擬定，及技術精進之有利工具。

肆、 國外工作日程表

<u>日期</u>	<u>行程</u>	<u>工作項目</u>
91.12.16 (一)	台北-美國加州洛杉磯	飛行中
91.12.17 (二)	洛杉磯-Hitco 公司	參訪及研討匿蹤研 改相關之技術與能 量。
91.12.18 (三)	洛杉磯-Hitco 公司	參訪及收集戰機風 擋、座艙罩設計、 座艙罩透明導電膜 濺鍍、材料。
91.12.19 (四)	洛杉磯-Richmond 公司	參訪及研討匿蹤研 改相關之技術與能 量、座艙罩光學檢 驗的規範與新技 術。
91.12.21 (五)	洛杉磯-Richmond 公司	參訪及收集航空用 導電塑化材料檢驗 需求、製造成型的 新技術。
91.12.22 (六)	美國加州洛杉磯-台北	飛行中

伍、 社交活動

無

陸、 建議事項

1. 依據出口法規可向 Hitco 與 Richmond 公司採購材料，提供相關專業組研究與分析，與本所「廬山計畫」所需之性能規格做比較，可作為後續研改的技術參考。
2. 鑒於本所推行軍民通用科技案繼續與 Hitco 與 Richmond 公司保持技術交流外，對於其他的民生產業的設計與製造技術可以引進國內，將此技術導入航太業，增加其附加價值。
3. Hitco 與 Richmond 原本是材料研發公司，迫於要拓展業務，積極導入系統的開發，其目的是要有成品，增加其材料品質的說服力，也因此成功地與軍方合作，得到雙贏的成果，這方面是值得我們效法的，「廬山計畫」的客戶是空軍，應積極滿足空軍的需求，事實上應該是三軍的需求，這對於未來向三軍爭取建案是有幫助的。
4. 本所「廬山計畫」在有限的經費下，製程的研擬可參考 Richmond 公司，透明導電膜濺鍍的技術，應與 Richmond 與 Hitco 公司保持聯繫。

附 件

附件 A Hitco Composite Inc. 公司簡介
<http://www.SGL-Hitco.com>

附件 B Richmond Aircraft Product Inc. 公司簡介
<http://www.RichmondAidcraft.com>

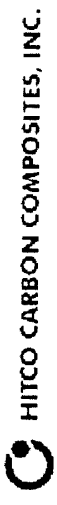
**Welcome to
HITCO Carbon Composites**

HITCO Carbon Composites is a provider of innovative material solutions and composite structures.

Our customer's span a variety of industries: aerospace, thermal management, metal and chemical processing, and automotive.

HITCO is number one globally in the business of rocket nozzles with more than a 60% market share, a leader in the global aerospace and defense advanced composites fabrication business for military and civil aviation, and the pioneer and leader in carbon-carbon brakes for military, civil and high performance race cars. We have more than a 60-year history in providing thermal managed solutions under the trademark Refrasil® , the worlds standard in refractory silica insulation systems.

HITCO Carbon Composites, INC.
1600 W. 135th Street, Gardena, CA 90249 USA
Phone: +1 800-421-5444
Fax: +1 310-516-5714



Who is HITCO?

HITCO Carbon Composites, Inc. is a major supplier of Composite Structural Assemblies and High Temperature Materials to the Aerospace and Industrial Markets. Founded in 1922 by Harry I. Thompson, **HITCO** is the oldest, continuously operating composites provider in the United States. Located on 26 acres just 10 minutes away from Los Angeles International Airport, **HITCO** is ideally situated to serve both domestic and international Aerospace customers.

What does HITCO have to offer?

HITCO has the know-how, facilities and equipment, business and quality processes, Lean Manufacturing principals, and most importantly, a track record of success to help our customers successfully transition traditional metal structures to composites.

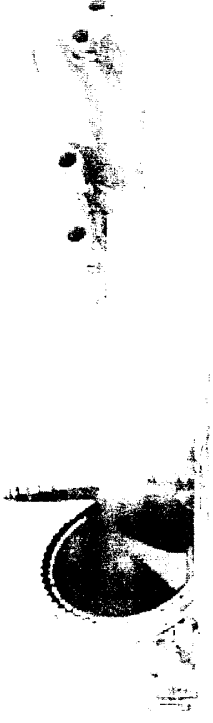


Know-How

HITCO employs over 150 hourly and salaried employees who exclusively engineer, fabricate, assemble and inspect aerospace composites. 60 employees are degreed, 17 have advanced degrees. The average tenure of these employees is over 14 years. **HITCO's** technical group has extensive experience in concurrently developing highly complex aerospace composites. To cite just two examples: both the C-17 Tailcone and Delta IV nozzle assembly were designed, tooled and delivered in less than 12 months, and despite tremendous change and considerable growth in complexity; **HITCO** was able to maintain or reduce its price to its customer.

Facilities and equipment

HITCO currently has approximately 400,000 square feet of manufacturing space under roof. About 75% of the total space, or 300,000 square feet is dedicated to manufacturing. Currently **HITCO** utilizes about 60% of this space, leaving 120,000 square feet open for new programs. Additionally, **HITCO** has all of the necessary equipment to fabricate large-scale high complexity assemblies. This equipment includes 5 large autoclaves 6 large paint-booths, N/C ply cutting and various large N/C mills and lathes.



Business and quality processes

HITCO is certified to ISO 9001, D1-9000 and AS 9100. HITCO has quality systems built to meet the most demanding Air-Force and FAA standards for documentation and process control. Further, HITCO has refined these systems to produce these records and documentation at the lowest total cost. The net result is 100% traceability and process control.

Lean manufacturing

HITCO's experience with lean manufacturing began over 8 years ago when it implemented its first JIT assembly line. Since that time, every major process and assembly has been re-engineered using lean principals. All new programs will utilize the best practices of this combined experience. Concepts like visual factory control, KanBan, Statistical Process Control and 5S will be implemented from the program inception. The benefits to our customers are shorter lead-times and lower unit prices.



Track record

The results of these efforts speak for themselves:

- Delta IV: Complex Nozzle assembly, conceived, designed, tooled and fabricated in less than 12 months, an Industry first.
- C-17: Large (12' high, 14' wide) complex structure using over 3500 fasteners is manufactured using less than 1000 hours.
- Boeing 767 Flap Track Fairings: 18 hybrid metal/composite subassemblies, fabricated start-to-finish complete in 20 manufacturing days.

In conclusion, **HITCO** is a supplier that has proven the ability to concurrently develop, tool and fabricate large complex, high risk, high value programs. HITCO is confident that our experience with flight critical hardware ensures our customers the highest quality product at the lowest possible cost.



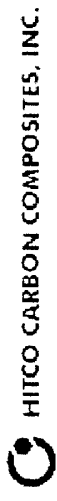
Company Profile

A brief history of HITCO CARBON COMPOSITES, INC.

IN 1922 Harry I. Thompson and his brother George formed Thompson Glass and Paint Company. The company sold window glass, plate glass and mirrors; paint in any shape or form was not manufactured or sold.

In approximately 1943, the company name was changed to H.I. Thompson Company, and in 1953 it was changed again to H.I. Thompson Fiber Glass. In 1966, the name became **HITCO**, a title which made display on the New York Stock Exchange board more simple.

HITCO was a publicly owned company from this time until 1969 when it was purchased in whole by Armco Steel. In 1985, Owens Corning Fiberglas purchased HITCO from Armco and in 1987, British Petroleum plc purchased us from Owens Corning. In 1990 the company's name was changed to BP Chemicals (**HITCO**) Inc. In 1995 BP Chemicals (**HITCO**) Inc. was sold to Veritas Capital, Inc. and the company's name was changed to Hitco Technologies, Inc. In 1997 **HITCO** was purchased by SGL CARBON GROUP, the largest supplier of advanced carbon and graphite applications in the world, and renamed **HITCO CARBON COMPOSITES, INC.**



Since our start, **HITCO** has grown from the single product line (glass and mirror) to a company that provides a wide range of commercial and defense reinforced plastic and metal products.

Prior to obtaining the Gardena facility, H.I. Thompson owned and operated facilities in Los Angeles, Inglewood, Long Beach, Atlanta and Canada.

Our Composite.

Structures and Insulation Systems Business and some of their current employees started in Los Angeles at the Cordova Street facility

The Inglewood facility produced insulation products, aircraft radomes and the then famous 120 foot diameter "Haystack" radome. The U.S. Air Force ordered this radome to be operated for global communication and space studies atop Haystack Hill in Massachusetts. At Long Beach fabricated the time it was the world's largest space frame radome.

and assembled the "Epic" casket, machined panels for the Haystack radome and welded and machined many rocket motor components.

The Canadian facility produced essentially the same aircraft insulation products for the Canadian market that Inglewood manufactured for the U.S. Market.



HITCO CARBON COMPOSITES, INC.



H.I. Thompson acquired the Dumont Company located in San Rafael, California, in February 1961, prior to the move to Gardena. Dumont fabricated rocket nozzles and exit cones and employed approximately 100 people. They were recognized by the industry as pioneers in design and fabrication of high temperature ablative components for missile and rockets. Programs that were brought to Gardena include the 120 inch Titan 3C exit cone, Polaris, Nike-Zeus, Minute Man first stage and the Surveyor (moon landing) exit cone.

The Gardena facility was owned and operated first by Zenith Plastics, fabricating radomes and commercially marketed and fabricated fiber glass chairs. In 1956 the 3M company purchased and operated it until H.I. Thompson bought the plant in 1961 and consolidated Dumont and the Los Angeles, Inglewood and Long Beach facilities. Part of this consolidation included moving several large autoclaves, hydroclaves and press molding equipment to Gardena.

Since our move to Gardena in 1961, many diverse products have been fabricated here, although our heart and soul has been aerospace products. The financial split in 1961 was reported as 24% insulation materials (Fibers & Materials Division), 15% commercial products (insulation, caskets and chairs), and 61% aerospace (Atlas, Minute Man, Titan, Polaris, Surveyor, Nike-Zeus, etc.).



HITCO designed and produced the Surveyor exitcone that was first landed on the moon and both the ascent and descent exitcones for the man landing on the moon. The man landing exitcones were used on as the Lunar Excursion Module (LEM) for the Apollo program.

The outer hull sections of the Navy's first Deep Submergence Rescue Vehicle (DSRV mini sub), the Polaris Pop-Up Enclosure (currently the Westinghouse D-5 Closures), submarine domes (637) and the L-1011 interiors and lavatories were all new products during the late 60's and early 70's. We also made a major switch to large metal fabrication of the first Terminal Island autoclave and lay-up fixtures for the 637 and 688 domes. Attach rings, foundation rings and holding fixtures were also fabricated during the start of our very successful Marine Product Line.

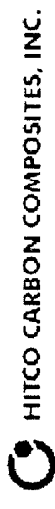
From experience developed during production of the L-1011 products, HITCO developed the aircraft interior upgrade kits known as CERI (Contemporary Enclosed Rack Interior). The 767 Flap Track Fairings were another result of our experience in commercial aircraft structures.



Through the years we have fabricated heat shields for C-4 and D-5 missiles. **HITCO** also produced the flexseal assembly of the D-5 missile.

The high temperature facility was started to support ablative products and was expanded in the late -70's for the products of aircraft and racing brakes.

Today, **HITCO CARBON COMPOSITES, INC.** produces a wide variety of fiber glass, carbon, graphite composite and metal materials and products. Our diversified business has recently been oriented to integrate **SGL CARBON GROUP's** core competency in carbon with our existing composites technology. This synergy has created unparalleled business opportunities in several markets. We have businesses in many aspects of the aerospace industry as well as commercial customers. Our testing and laboratory facilities include the Process Development Laboratory in Building 15 which is used to develop and test material performance, the Advanced Radiographic Facility which is state-of-the-art, as well as numerous product development and research lab facilities.



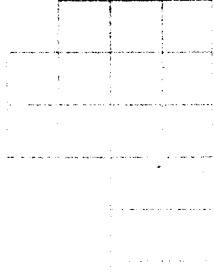
Vision

It is our goal to achieve global leadership in development and manufacturing of carbon-based composite materials and components

We employ key alliances, excellent science, capable committed suppliers and superior human assets as we implement our chosen strategies toward the achievement of our goals in pursuit of our vision.

At HITCO, we have been at the leading edge in the development and manufacture of carbon-based composite materials and components for over 50 years. Today, as materials technology is changing more rapidly than ever before, we are committed to achieving innovative solutions for our customer's most demanding needs.

As one of the world's largest integrated manufacturers of high-temperature material including carbon/carbon and advanced engineered composite structures, we have designed, developed and manufactured a wide array of products. Innovative applications of our sophisticated technologies include aircraft and automotive brake components, jet engine flaps and seals, solid rocket motor nozzles, heat shields, and material used in the manufacture of high-tech semiconductors. Our expertise in these specialized areas is so extensive that many of our customers have made us their preferred long-term supplier partner. Let us know how we can help your business!



World Class Manufacturing

HITCO's exceptional systems, documentation and traceability comply with the highest industry standards. HITCO is compliant to various quality system standards including ISO 9001, DI-9000A, AS 9000, and MIL-Q-9858A.

HITCO has received these distinguished awards from our customers:

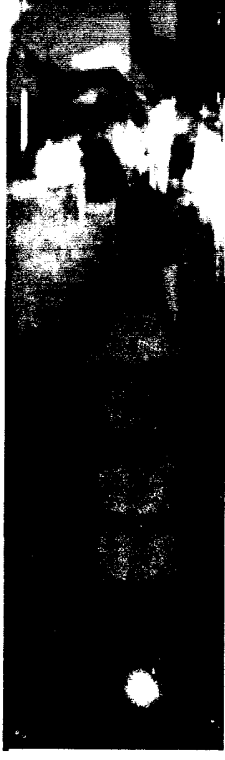
<u>Award</u>	<u>Year</u>	<u>Customer</u>
Supplier of the Year	1999	Boeing
Silver Eagle Award	1997	McDonnell Douglas
Supplier of the Year	1995	Rockwell International

HITCO occupies a 26 acre facility in Gardena, CA, with capabilities that range from production facilities and equipment to complete R&D facilities. When necessary, we also have access to similar facilities located in other business unit locations throughout the world. We have one of the world's most extensive carbon/carbon processing facilities, including many large high-temperature furnaces used for pyrolysis, CVI, densification and heat treating up to 11 ft. (3.4 m) in diameter, capable of processing at up to 5000°F (2760°C) critical steps in the manufacture of carbon/carbon products. Equipment encompasses large-scale autoclave equipment, to state-of-the-art laboratory and testing equipment including real time radiography.

Quality Systems: System Registration, Certification, Compliance

Qualifications: Customer Approved Processes

Facilities: Equipment and Process Capabilities



Quality Systems

HITCO's quality systems are robust, flexible and remain responsive to customer needs through an experienced implementation team. HITCO conforms to the following quality systems:

- ISO 9001 Registered (#FM40991)
- D1-900A Boeing Commercial QA System
- AS9000
- MIL-Q-9858A
- ANSI ASTM Z-540 - Calibration

We are registered to ANSI/ASQC Q9001:1994 "Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation, and Servicing" through British Standards Institution, Inc., certificate number FM 40911, issued on November 13, 1998. DCMC provided a qualification declaration after evaluating our system and founding it to be in compliance with ISO 9001 on May 7, 1999.

Boeing has approved our system to D1-9000A. Within one year from now we will be approved to D6-82479 N/C which is AS9100:2000 (latest standard) and Boeing's special purchase order clauses.

HITCO is compliant to aerospace standard AS 9100 "Quality Systems - Aerospace - Model for Quality Assurance in Design, Development, Production, Installation and Servicing" issue 1999-11; and AS 9000 "Aerospace Basic Quality System Standard" issue 1997-05.



Qualifications

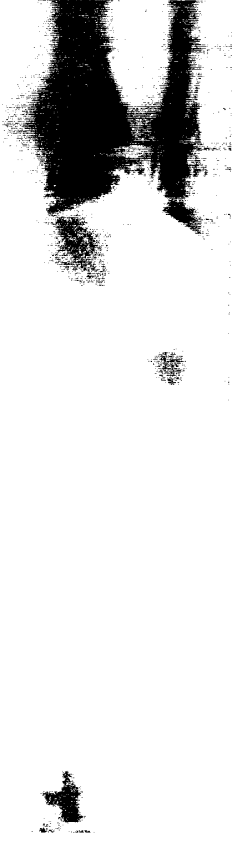
Process

MIL-STD-453
ASTM-103
MIL-I-8950
MIL-I-6866
OD-19258
FED-STD-406
FED-STD-151
DPS4.738-2
BAC 59801
BSS 7698/NAS410/MIL-STD-410
MIL-F-18264
SPC-36652
MIL-W-6858
BAC 5317
BAC 5317-5
DPS1.960
DPS1.624
BMS 8-330B

Customer approved processes at HITCO include:

Description

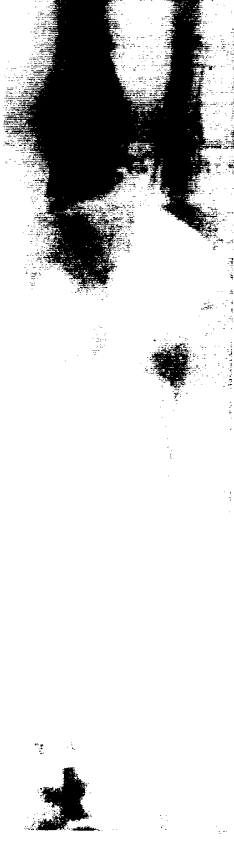
Radiography Inspection
Ultrasonic Inspection
Ultrasonic Inspection
Penetrant Inspection
Alcohol Penetrant Inspection
Plastic Methods of Testing
Metal Testing Methods
Ultrasonic Inspection - Composite Structures
NDI of Composite Parts - Structures
NDI Personnel Certification Level III Ultrasonic
Finishes Organic Weapons Systems
Special Finishes
Resistance Welding: Spot-Seam
Fiber Reinforced Composite Parts
Mfg of Advanced Composite Structure Parts 250F Cure
Adhesive Bonding - Composite Structures
Autoclave Processing of Carbon Epoxy
Flexible High Temperature Insulation Blankets



Facilities

HITCO CARBON COMPOSITES occupies a 26-acre manufacturing facility located in Gardena, California. Our capabilities range from production facilities and equipment to complete R&D facilities. When necessary, we also have access to similar facilities located in other business unit locations throughout the world.

We have one of the world's most extensive carbon/carbon processing facilities, including many large high-temperature furnaces used for pyrolysis, CVI, densification and heat treating up to 11 ft. (3.4 m) in diameter, capable of processing at up to 5000°F (2760°C) critical steps in the manufacture of carbon/carbon products. Equipment encompasses large-scale autoclave equipment, to state-of-the-art laboratory and testing. HITCO can also provide lay-up, bonding, bagging, inspection, and machining expertise in a number of advanced composite materials and metals.



EQUIPMENT CAPABILITIES

Manufacturing equipment

Equipment Type

Autoclaves

Capabilities

Pressure Ranges from 205 psig (1413 kPa) to 300 psig (2069 kPa)

Temperature Ranges from 350°F (177°C) to 650°F (343°C)

Dimensions from 65 in x 144 in (1.65 m x 3.66 m) to 176 in x 480 in (4.47 m x 12.19 m)

Hydroclaves

Pressure 1000 psig (6895 kPa)

Temperature 350°F (177°C)

Dimensions from 56 in x 75 in (1.42 m x 1.91 m) to 116 in x 120 in (2.95 m x 3.05 m)

Verticle Turret Lathes

Swing Ranges from 72 in (1.83 m) to 120 in (3.05 m)

Height Ranges from 72 in (1.83 m) to 119 in (3.02 m)

Furnaces/Ovens

Temperature Ranges up to 5000°F (2760°C)

Dimensions up to 14 ft wide x 15 ft high x 22 ft deep

CNC Horizontal Boring Mill

5 Axis



CNC Horizontal Lathes

Swing 31 in
Height 81 in

DCS 2500 Automated
Ply Cutter, Waterjet cutter

Length 45 ft

Tape Wrap Machines

Swing Ranges from 4 ft to 14 ft

Presses

Pressure Ranges from 50 ton to 2100 ton
Daylight Range from 38 in to 94 in

Coolers Freezers

Temperature Ranges 32°F to 40°F
Total Storage 1150 sq ft
Total Storage 1125 ft



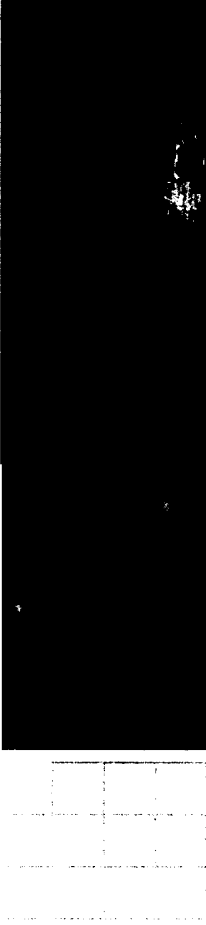
HITCO CARBON COMPOSITES, INC.



X-Ray capabilities

Our advanced radiographic facility is capable of standard and real-time radiography and ultrasonics for nondestructive testing. Model 1000A Linatron Linear Accelerator Seifert 420 x-ray machine

- 2 million and 6 million electron volt sources (1000A) linear accelerator with real time computer operated imaging
- 30 to 420 kilovolt source (Seifert)
- 1% radiographic sensitivity
- Film and computer automated real time radiography
- Capable of penetrating fifty (50) inches of carbon and suitable for thin wall structures
- Capable of meeting stringent aerospace x-ray quality requirements
- Accommodates parts up to 13 ft in diameter, 11 ft long and up to 20,000 lbs.
- Certified inspectors



Links / Affiliations

We are proud to be associated with these organizations. The links on this page open in a new browser window. Close the window to return to our site:

General Engineering Associations

- [The American Society of Mechanical Engineers](#)
- [American Institute of Chemical Engineers](#)
- [Institute of Electrical and Electronic Engineers \(IEEE\)](#)
- [Society of Manufacturing Engineers \(SME\)](#)
- [National Society for Professional Engineers \(NSPE\)](#)
- [American Society for Testing Materials \(ASTM\)](#)

Fibers and Fabric

- [Society for the Advancement of Materials and Process Engineering \(SAMPE\)](#)
- [American Fiber Manufacturers Association \(AFMA\)](#)
- [Industrial Fabrics Association International](#)



Felts

- [Society for the Advancement of Materials and Process Engineering \(SAMPE\)](#)

Insulation

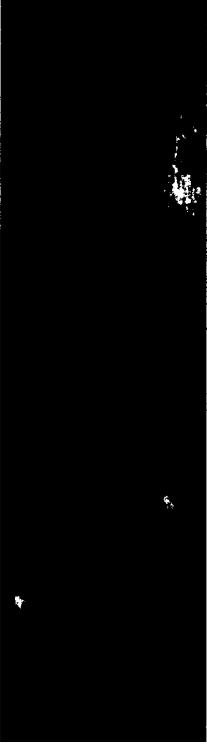
- [Society for the Advancement of Materials and Process Engineering \(SAMPE\)](#)
- [North American Insulation Manufacturers Association \(NAIMA\)](#)
- [National Insulation Association \(NIA\)](#)

Carbon Fiber Reinforced Plastics

- [Society for the Advancement of Materials and Process Engineering \(SAMPE\)](#)
- [Society for Plastics Engineers](#)
- [The Society of the Plastics Industry](#)

Nozzles

- [Society for the Advancement of Materials and Process Engineering \(SAMPE\)](#)
- [American Institute of Aeronautics and Astronautics](#)



Aircraft and Composite Structures

- [Society for the Advancement of Materials and Process Engineering \(SAMPE\)](#)
- [American Institute of Aeronautics and Astronautics](#)
- [Aerospac Industries Association \(AIA\)](#)
- [Association of Manufacturers and Manufacturers Association \(AMMA\)](#)
- [Composément des Industries Françaises Aéronautiques et Spatiales \(CIFA\)](#)

Automotive Components

- [Specialty Equipment Market Association \(SEMA\)](#)
- [Society of Automotive Engineers \(SAE\)](#)
- [United States Council for Automotive Research](#)
- [Glass and Equipment Manufacturers Association \(GEMMA\)](#)

Furnace Components

- [International Equipment and Materials International \(SEMI\)](#)
- [American Society for Metals \(ASM\)](#)
- [International Heating Equipment Association \(IHEA\)](#)



Aircraft Engine Parts

- [Society For the Advancement of Materials and Process Engineering \(SAMPRE\)](#)
- [International Gas Turbine Institute \(ASME GTI\)](#)

Thermal Management for Electronics

- [Institute of Electrical and Electronic Engineers \(IEEE\)](#)
- [International Microelectronics and Packaging Society \(IMAPS\)](#)

Radiant Tubes

- [American Ceramics Society](#)

Armor Protection

- [H.P. White Laboratory, Inc.](#)
- [Personal Protective Armor Association \(PPAA\)](#)
Robert V. Wantz

3623 Falls Rd. Baltimore, MD 21211 USA Telephone: (410) 889-3136



Energy Systems

- www.fuelcell.org (Fuel Cell Association of the Americas (FCAA))
- **American Association for Fuel Cells**
50 San Miguel Ave.
Daly City, CA 94015 USA
Telephone: (650) 992-3963
- **Fuel Cell Institute (FCI)**
Formerly: Fuel Cell Association
PO Box 65481, Washington, DC 20035-5481 USA
Telephone: (301) 681-3532
Fax: (301) 681-4896

Space Mirrors and Satellite Components

- www.aiaa.org (American Institute of Aeronautics and Astronautics)

Glass Manufacturing Components

- www.glasspackaging.com (Glass Packaging Institute)
- www.nga.org (National Glass Association (NGA))
- **Primary Glass Manufacturers Council (PGMC)**
Formerly: National Fenestration Council
White Lakes Professional Bldg.
3310 SW Harrison St.
Topeka, KS 66611-2279 USA
Telephone: (913) 266-3666
Fax: (913) 266-0272
- **Research Association of the German Glass Industry**
Huettentechnische Vereinigung der Deutschen Glasindustrie (HVG)
Mendelssohnstrasse 75-77, D-60325 Frankfurt, Germany
Telephone: 49 69 9758610
Fax: 49 69 97586199 E-Mail: GHI@HVG.com <http://www.hvg.com>
- www.glassindustry.com (Glass Manufacturing Industry Council (GMIC))



Corrosion Resistant Products

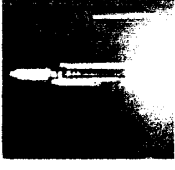
- [National Association of Corrosion Engineers \(NACE\)](#)
- [American Society for Metals \(ASM\)](#)
- [National Petroleum Refiners Association \(NPRAI\)](#)
- [Fiberglass Reinforced Plastics Manufacturers Association \(FRMA\)](#)
- [Chemical Manufacturers Association \(CMA\)](#)
- [American Chemical Society \(ACS\)](#)

Filtration/Separation

- [American Filtration & Separations Society](#)
- [Filtration Society](#)
- [Filtration Society](#)
- [Association of Nonwoven Fabrics Industry](#)

Miscellaneous Organizations

- [Filtration Society](#)
- [Filtration Society](#)
- [Filtration Society](#)

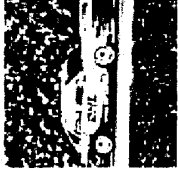
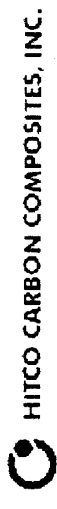


Aerospace

50 Years of experience

HITCO manufactures composite parts for aerospace and defense as well as automotive, chemical processing, electronics, energy, filtration/separation, heat treating, semiconductor, and the transportation industries. We utilize various manufacturing techniques to produce composite products and materials for use in high temperature, low friction, and structural applications.

Our business unit organizational structure ensures that customers receive the concentrated technical, management and production support required for the on-time delivery of quality, cost-competitive composite structures and assemblies.



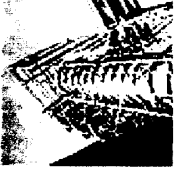
Automotive

Our composites create new opportunities for structural design and safety

HITCO has expertise in a variety of automotive applications including automotive and racing brakes for Formula One racecars; thin carbon carbon sheet materials (CVD fabrics) used in transmissions and limited slip differentials; new development programs are looking into the feasibility of producing connecting rods for specialist racing engines; and other high temperature and high precision engine components.



HITCO CARBON COMPOSITES, INC.



Chemical

We put the "X" in "extreme" environments.

Corrosion in the chemical processing industry costs producers millions of dollars every year. Carbon based materials offer excellent corrosion resistance.

HITCO has been combating corrosion with its carbon composite materials technology for decades. Our revolutionary solutions have helped chemical producers to solve material problems in the most highly corrosive environments.

With the continuing advances in chemical processing, **HITCO** is dedicated to offering pioneering solutions for the most demanding processes and environments. Carbon/Carbon provides corrosion resistance with structural properties similar to those of titanium. C/C components therefore find use in the chemical process industry (CPI) particularly as distillation column packings (both structured and loose), distillation trays and tray supports, mist eliminators, thermowells, sparger tubes, feed pipes, and pump impellers.

Our carbon composite materials technologies combine the chemical resistance of graphite with the structural properties of metals and can be engineered into various shapes and sizes.

Our dedicated staff of engineers and scientists can offer you the expertise needed to design a cost effective solution useful for an array of chemical process applications.



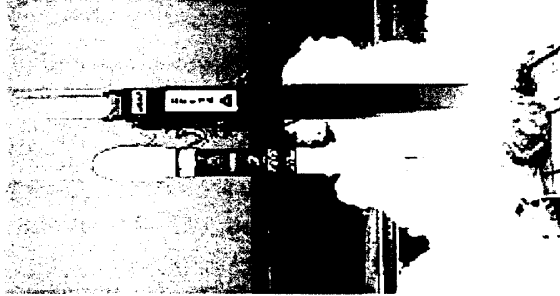
Defense

A valued supplier to the world's most respected defense companies.

HITCO has a rich background working with customers to design unique and large composite structures (such as the Seawolf class submarine bow domes), and high temperature material applications (i.e. Carbon-Carbon braking systems for military aircraft, heat shields, jet exhaust protection, and rocket motor nozzles, just to name a few).

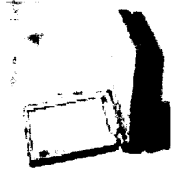
Engineered Solutions

As one of the world's largest integrated manufacturers of high-temperature materials including Carbon/Carbon and advanced engineered composite structures, we have designed, developed and manufactured a wide assortment of products.





HITCO CARBON COMPOSITES, INC.

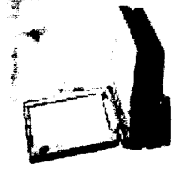


Semiconductor

As the demand for new electronic devices increases, the demand for equipment to produce these devices continues to escalate.

The development of ever more versatile electronic equipment at steadily increasing performance/price ratios and the resulting application of electronic devices in more and more areas of our daily lives lead to ever increasing customer demands. Basically, Moore's law still holds: device complexity doubles every 18 months. Entirely new developments, new approaches to novel technologies - new generations of electronic devices make this happen.

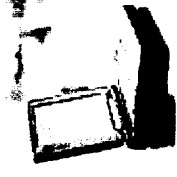
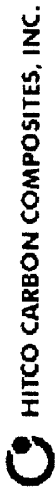
Advances in electronic technology require complex materials and production methods. The field of semiconductor manufacturing has forced the material processing envelope to expand into a complex field. One method for producing semiconductor crystals is a process known as Crystal Pulling.



How it is done:

For the production of quality semiconductor crystals, the following basic method is followed: The first step in the wafer manufacturing process is the formation of a large, silicon single crystal or ingot. This process begins with the melting of polysilicon, together with minute amounts of electrically active elements such as arsenic, boron, phosphorous or antimony in a quartz crucible.

Once the melt has reached the desired temperature, a silicon seed crystal, or "seed" is lowered into the melt. The melt is slowly cooled to the required temperature, and crystal growth begins around the seed. As the growth continues, the seed is slowly extracted or "pulled" from the melt. The temperature of the melt and the speed of extraction govern the diameter of the ingot, and the concentration of an electrically active element in the melt governs the electrical properties of the silicon wafers to be made from the ingot. This is a complex, proprietary process requiring many control features on the crystal-growing equipment.



Solution:

Our SEMICARB® material, developed as an extension of our Carbon/Carbon technology, has opened markets for us in high-tech industries such as semiconductor manufacturing. This high-temperature material enables our customers to replace graphite with an alternate material that exhibits superior strength, purity and lifetime performance with the added benefit of enlarging the crystal size capacity. Because it is strong, a 0.25" thick piece of C/C can replace a piece of graphite over 1" thick, thereby increasing the effective capacity of the crystal pulling furnace.

HITCO has R&D, prototyping, scale-up, and testing capabilities at our facilities, and we would welcome the opportunity to develop a materials or component solution for your specific application. We are ISO 9001 certified, and have the experience in providing customers solutions at optimal performance levels while being ever mindful of cost considerations.



Aircraft Structures

HITCO Carbon Composites has been supplying composite structures to the Aerospace Industry since 1943. Today, **HITCO** provides primary and secondary assemblies for military and commercial aircraft. Our fabrication experience has included program production runs of over 800 ship sets. Our dedicated program management system also supports R&D, start-up and validation activities. We have extensive experience in the following types of assemblies and structures:

- Bonded or mechanically fastened composite/metallic assemblies up to 15 feet in diameter
- Complex mechanical assembly ■ Honeycomb and closed cell foam stiffened composites
- Co-cured and bonded composites ■ Integral rib bead and hat stiffened structures
- Epoxy, phenolic and BMI pre-preg systems

We support these fabrication capabilities with world class manufacturing operations that utilize the following capabilities:

- Lean manufacturing ■ Value engineering
- Fully integrated ERP management
- Complete ultrasonic and system ■ ISO 9000, D1-9000A and AS-9100 certified quality systems
- Complete supply chain x-ray testing including real time radiography (Level 3 certified inspectors)
- NC machining and ply cutting ■ Complete process documentation and traceability
- Hydroclave, autoclave and compression molding ■ CAD platforms: Catia, FiberSim, Pro-E, Mechanical Desktop, Autocad
- Full surface preparation including Aero-fairing, prime, lightening strike coatings and final paint.



Flap Track Fairings

HITCO is an industry leader in close-tolerance, complex-shaped composites manufacturing.

Complex Structures: For more than half a century, **HITCO** has been developing and producing complex composite structures for commercial and military aircraft. The Boeing 767 Flap Track Fairings that have been produced at **HITCO** since 1982 are organized into lean flow production lines, employing just-in-time material deliveries and dedicated cross-trained production teams. Each shipset consists of 24 close-tolerance, complex-shaped components. Flap Track Fairings are located on the underside of the wings and offer protection for the flap control mechanism as well as improved aerodynamic stability.

Aircraft business supports customer needs

Our Composite Structures Business Unit is focused on the customer to ensure they receive concentrated technical, management, and production support required for the on-time delivery of quality, cost-competitive structures and assemblies. We concentrate on the production of aircraft composite structures of medium complex shapes requiring hand lay-up techniques. We use glass, carbon/graphite and aramid epoxy preregs, and various core materials such as honeycomb and structural foams.



Radomes

HITCO is known for manufacturing breakthroughs.

Experience in Advanced Composite Structures: HITCO has produced over 700 individual Radomes for both Ground, Shipborne, and Aircraft requirements. HITCO utilizes honeycomb, composites, and solid laminates in electromagnetic window construction.



Lockheed C-130:
HITCO designed and developed the Fluted Core Nose Radome utilized on the Hercules aircraft.



HITCO CARBON COMPOSITES, INC.



Composite Tailcones

Over 50 years of experience in the design and manufacturing of large composite structures.

Large Structures: The Boeing C-17 Tailcone assembly showcases our large composite structure manufacturing and assembly capabilities. This oversized component is a 12 ft. (3.7 m) long and nearly 11 ft. (3.4 m) wide, single-piece carbon epoxy structure, reinforced with longitudinal carbon epoxy stiffeners and metallic frames. Our experienced production teams meet critical contour tolerances and hinge location requirements for mating our component to each aircraft fuselage, assuring ease of assembly by our customer.



HITCO CARBON COMPOSITES, INC.

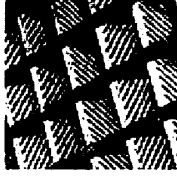


Chemical Process Industry Components (CHEMCARB™ Carbon/Carbon Composites)

HITCO's CHEMCARB™ Carbon/Carbon Composites provide revolutionary solutions in highly corrosive chemical environments.

CPI Components: Corrosion costs the chemical process industry (CPI) millions of dollars every year. HITCO offers CHEMCARB™ Carbon/Carbon, a composite material, to address highly corrosive environments. Because CHEMCARB™ Carbon/Carbon composites consist of carbon fibers surrounded by a carbon matrix, the material is, by nature, very resistant to a wide variety of chemical products used or manufactured in the CPI.

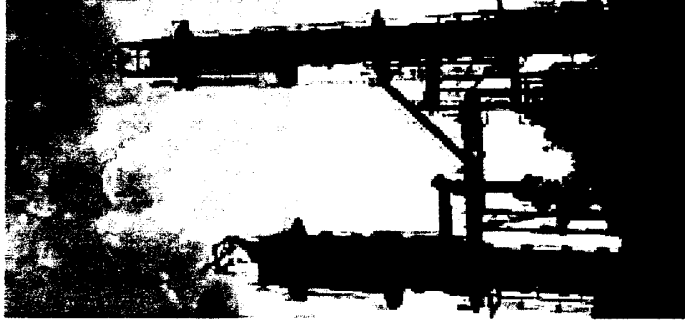
Carbon-based materials like graphite have excellent corrosion resistance. Carbon/Carbon has similar resistance together with structural properties similar to those of titanium. C/C can be used to fabricate components as varied as distillation column packings (both structured and loose), distillation trays and tray supports, mist eliminators, thermowells, sparger tubes, feed pipes, and pump impellers useful in highly corrosive environments.



CHEMCARB™ Composites offer:

- The corrosion resistance of graphite
- The structural strength of metals
- Excellent thermal shock resistance
- Good impact strength
- Low density
- Design versatility

CHEMCARB™ products offer excellent performance over wide ranges of concentrations, temperatures, and impurities in HF, HCl, H₂SO₄, H₂S, H₃PO₄, HBr, acetic acid, caustic, and a wide variety of other organic and inorganic chemicals.





HITCO CARBON COMPOSITES, INC.



Corrosion Resistance

Meeting your most demanding needs:

HITCO produces materials, components and systems that have unique material properties that help to make our customer's systems impervious to harsh chemical environments. The properties of the materials allow customers to save cost and time by reducing unnecessary down-times, and increased life cycles.

Our vast expertise in carbon-based materials is allowing us to develop materials that offer excellent corrosion resistance at an affordable price. HITCO has the capability of producing a variety of carbon materials and the ability to adapt their properties over a wide range, providing customized corrosion resistant components.



Thermal Protection

Contain your heat source with performance materials and components from HITCO

HITCO is a world leader in design and manufacture of specialty materials and components for thermal protection. Insulation materials are made from various forms of carbon and silica materials that offer optimal benefits such as thermal performance, durability, corrosion resistance, acoustic performance, weight reduction and cost.

HITCO also offers the value-added service of design and engineering. Insulation products can be tailored to customer specifications, drawing upon our extensive experience with both metallic and non-metallic insulation materials. Our experience with high-quality, custom insulation products was forged in the aerospace industry, then quickly diversified into a broad spectrum of markets that include: aircraft, heavy industrial, chemical processing, power generating, personnel safety, automotive, foundry & forging, and basic metals processing.



Thermal Insulation Blankets



Protect and insulate people and equipment against temperatures up to 2300°F

HITCO Carbon Composites, Inc. is a world leader in design and manufacture of specialty insulation components.

Insulation components are fabricated from a wide range of high temperature fabrics, non-wovens and metal foils. The design of insulation products can be tailored to customer specifications, drawing upon our extensive experience with both metallic and non-metallic insulation materials to optimize:

- Thermal performance
- Durability
- Acoustic performance
- Size
- Weight Reduction
- Cost



Our experience with high-quality, custom insulation products was forged in the aerospace industry, then quickly diversified into a broad spectrum of markets that include:

- Aircraft
- Heavy Industrial
- Basic Metals Processing
- Chemical Processing
- Power Generating
- Foundry & Forging
- Personnel Safety
- Automotive

Products and Applications:

Heat Shielding

- Protective Shrouds
- Firewalls
- Splash Shields
- Electrical Control Covers
- Fire Penetration Seals
- Oven/Furnace Blankets & Covers
- Door & Access Port Covers for Boilers, Furnaces & Engines

Heat Containment

- Heat Exchangers
- Steam Line Insulations
- Valve/Flange Covers
- Manifold Covers
- Exhaust Systems
- Hydraulic/Pneumatic Line Wraps
- Welding Blankets
- Slow-Cool Blankets Stress Relieving Pads



Fabrication Techniques:

- Coated & Aluminized Components
- Metal Foil Forming
- Non-Metal Composite Blankets
- Molded Shapes
- Metal-Clad Blankets
- Texturization
- Die Cutting
- Vacuum-Cured Composites
- Sewn-Cloth & Non-Wovens



Aircraft Brakes

Our materials are already in use on some of the world's most well-known aircraft.

We have been manufacturing Carbon/Carbon (C/C) brake materials from their initial development on high performance military aircraft through the wide spread acceptance on commercial aircraft. Our C/C materials are qualified on a number of military and commercial aircraft. Years of production and development of aircraft brakes have led to new products and applications utilizing the technology and unique properties of carbon/carbon.



Automotive Racing Brakes

We introduced the application of Carbon/Carbon brakes to Formula One teams

Automotive Racing Products: Carbon/Carbon (C/C) brakes are at their premium performance levels in high energy situations. They have outstanding thermal shock resistance, do not fade, offer consistent brake performance, are light weight and wear resistant. The brake rotor and pads are made entirely from C/C as it provides both structural and frictional properties.

We developed the first automotive racing application of Carbon/Carbon brakes for Formula One teams. Today we utilize the focused business line concept to develop and produce friction products for a growing list of customers on the move. This concept concentrates our expert personnel and production equipment to support existing and new friction products and customers, optimizing throughput and service while minimizing costs. Our world-class product offering includes brakes, clutches and other friction products for aircraft, trains, trucks and automobiles.



HITCO CARBON COMPOSITES, INC.



Clutch Plates

Carbon/Carbon is a valuable material for racing applications.

Automotive Racing Performance Improvements: Single piece Carbon/Carbon (C/C) discs are used as both the friction surface and structural backing for clutch plates. The combination of light weight, high strength and wear resistance in high energy conditions makes C/C a premium clutch material in racing applications. HITCO has experience in these types of applications, and we would be happy to assist you in solving your most demanding challenges.



HITCO CARBON COMPOSITES, INC.



CVD Fabric Wet Friction Material

SGL materials find outstanding advantages in the automotive industry...

Wet Friction Components: CVD Fabric consists of a carbon fiber fabric onto which has been deposited a thin layer of carbon by chemical vapor deposition (CVD).

CVD Fabrics illustrate the acceptance of a high tech aerospace material into full production, consumer automotive applications. As an outgrowth of our Carbon/Carbon aircraft brakes business, our CVD Fabrics are used in a patented wet friction application for automotive differential components and truck transmission synchronizers. Carbon/Carbon Fabrics offer outstanding advantages in harsh, higher temperature, high unit loading wet friction applications where high performance and smooth operation is required.



HITCO CARBON COMPOSITES, INC.



Friction / Tribology

Get a grip on HITCO solutions for friction and tribology.

HITCO has long been interested in the chemistry, physics, and mechanics of interacting surfaces in relative motion. Our vast experience in material science and specifically carbon composites has helped us to make many contributions to the study of tribological science. HITCO has many years of experience developing materials and systems that deliver exceptional coefficients of friction and wear resistance under the most demanding applications. We helped to pioneer the first automotive racing application of Carbon/Carbon brakes and clutches for Formula One teams. Our friction technologies have proven to offer not only excellent performance but also cost competitive solutions to many customers. If you have a demanding friction application, our dedicated staff of engineers is ready to help you with the right solution!

Today, our world-class product offering includes brakes, clutches and other friction products for aircraft, trains, trucks and automobiles



HITCO CARBON COMPOSITES, INC.



CERACARB® Products

Solving unique and demanding challenges is our specialty.

Advanced Processes Create New Products: Our new Silicon Carbide/Carbon (SiC/C) products are part evolution, part revolution. That's because we not only have experienced production teams that know how to fabricate next-generation products, but also the product development expertise and facilities necessary to create new product forms and materials to support emerging market developments.

New SiC/C processes and products created in our R&D centers are focused on providing solutions for customers with the most unique and demanding high-performance material challenges. HITCO has the talent, resources, and experience to convert new product concepts into One of our Carbon/Carbon derivativesreliable high-quality production.

, CERACARB® products were developed to replace metal components in high-performance, military aircraft engine afterburners. It offers longer life, reduced maintenance, lower-weight, and has the ability to survive in this highly turbulent, oxidizing environment.



Characteristics:

- Above 800°F (425°C), C/C oxidizes rapidly. Oxidation protection systems (OPS) vary with the temperature regime. At lower temperatures, oxygen getters or inhibitors are added to the matrix. A surface coating is also deposited to prevent oxygen ingress. However, at temperatures greater than 2800°F (1500° C), mission cycles typical of advanced aircraft and space vehicle launches/re-entries, conventional OPS do not work.
- In SiC/C composites, the carbon fibers are replaced with SiC fibers. The composite is then coated with vapor deposited SiC. As the fibers are thermally compatible with the coating, an effective OPS is formed. These composites have been used very effectively in high temperature applications such as the afterburner section of a jet engine, where SiC/C plates are used to vector the hot gases for optimum thrust. These composites also raise the threshold of the oxidation of carbon bearing composites and are being exploited for high temperature components.



HITCO CARBON COMPOSITES, INC.



Carbon / Carbon

Carbon Fiber Reinforced Carbon:

Our Carbon/Carbon composite materials have been industry leading for 30 years. We developed the first 2D Carbon/Carbon exit cones for high-performance solid rocket nozzle, helped pioneer friction applications for aircraft, and pioneered coated and oxidation-resistant Carbon/Carbon aeropulsion products. Material properties, designs and manufacturing processes are optimized to match each individual application. We perform product development in close cooperation with leading system suppliers and potential users. To complement our technology and engineering expertise, and to make our ideas into reality, we have one of the largest throughput capacities in the world for manufacturing Carbon/Carbon composites.

Customers benefit from our expertise:

Our process expertise covers the entire range of carbon composites and extends from carbon fibers, woven fabrics and prepregs to Carbon Fiber Reinforced Plastic (CFRP) components, Carbon/Carbon products and solutions in Carbon/Silicon Carbide (C/SiC).

Many years of research and development work have paved the way for the economic use of carbon composites in various sectors of industry. Carbon fibers and composites have exceptional properties, and whatever effort it takes to manufacture them, their only justification is their economic interest in our customers' systems and facilities.



HITCO CARBON COMPOSITES, INC.



What is Carbon-Carbon?

The first stages in the production of C/C is similar to that in the production of carbon fiber reinforced phenolic. Subsequent processing usually invokes one or two routes.

In the first route, commonly referred to as LPI, (liquid phenolic impregnation), the phenolic resin composite is heated to high temperatures in the absence of air. This process is known as carbonization and results in the formation of a carbon char. The resultant porous media is then infiltrated with more phenolic resin and further carbonized. This cycle is repeated until a specific carbon content is reached. This is usually measured by the density and, in the case of LPI, C/C is in the range of 1.5 to 1.6 g/cc.

In the second route to C/C commonly referred to as CVI (chemical vapor infiltration), the phenolic resin composites is first carbonized at temperatures up to 2,500° C (4,500° F) to create a porous structure. It is then subjected to the chemical vapor infiltration process. In this step a hydrocarbon gas (natural gas or mixtures of methane and other gases) is “cracked” at about 1000° C. The resulting carbon is deposited in the porous carbon fiber structure. Although this process is much longer than the LPI route, mechanically superior materials can be made!

Carbon/Carbon has a unique balance of properties. The high temperature capability coupled with its high friction behavior makes it the choice for aircraft and racing car brakes. (Other structural applications rely on its ability to retain high levels of strength at temperature. Specific varieties of C/C exhibit very high levels of thermal conductivity. This coupled with its low coefficient of thermal expansion make it ideal for spacecraft heat exchangers, for example.



C/C Properties:

Composites consisting of carbon fibers held together by carbon deposits. The carbon deposit is also referred to as the carbon matrix.

- The carbon fibers and carbon matrix are derived from a variety of sources. The most common carbon fibers are those derived from petroleum by-products such as pitch and synthetically produced fibers called PAN fibers. The matrix carbon is produced by the pyrolysis of resins or by reducing hydrocarbon gases such as methane to deposit carbon from the vapor phase.
- The composite properties are largely a function of fiber orientation. Thus, C/C materials are a family of composites, varying from randomly oriented chopped fibers in a carbon matrix to woven fabrics in a carbon matrix. Mechanical strength and stiffness are governed by fibers. The carbon matrix influences thermal properties and fatigue strength.
- Carbon/Carbon materials are used when light weight, chemically inert and/or high temperature strength are important issues. For example, tailored C/C materials surpass superalloys in specific strength, and copper and gold in thermal conductivity.
- Originally developed for high performance aircraft and space vehicles, these composites are used as aircraft and other brakes, vacuum furnace parts, in chemical reactors and a host of other industrial applications.



HITCO CARBON COMPOSITES, INC.



Carbon / Silicon Carbide

HITCO offers unique solutions to your most dynamic challenges.

Spurred on by the need to develop lower cost oxidation-resistant varieties of Carbon/Carbon (C/C), HITCO engineers and researchers have been pursuing the development of ceramic matrix composites (CMC).

The result has been a carbon fiber-reinforced ceramic material, which combines the strength and tenacity of carbon fiber materials, with the hardness and the oxidation resistance of silicon carbide (SiC).

C/SiC materials are produced from porous Carbon/Carbon. In a subsequent processing step, preforms are exposed to molten silicon by the Liquid Phase Infiltration (LPI) route. When this happens, the silicon reacts with the carbon matrix first to convert it to silicon carbide (SiC). The trick here is to control the reaction so that all the carbon matrix is converted with no conversion of the load carrying carbon fibers.



HITCO CARBON COMPOSITES, INC.



The main characteristic are:

- Low density - less than 2.7 g/cm
- High thermal stability - up to 1350° C/2450° F
- Excellent wear resistance
- Low thermal expansion
- High thermal shock resistance
- High dimensional stability and shape retention
- High specific heat capacity
- Good thermal conductivity
- Chemical resistance
- Electrical conductivity

C/SiC materials and components were first successfully used in aerospace and satellite technology. Further development by HITCO of the materials and production processes has substantially improved the cost/performance ratio of the materials. This has opened up the use of the materials for many other industrial applications.



Silicon Carbide / Carbon

Silicon Carbide Fiber Reinforced Carbon.

One of the drawbacks of Carbon/Carbon (C/C) materials are their limited resistance in oxidizing atmospheres. At temperatures above 400°C Carbon/Carbon begins to lose weight through oxidation. Some applications require the high temperature performance plus oxidation resistance. Applications include aircraft engine parts and leading edges for supersonic and hypersonic vehicles.

HITCO has developed composite materials based on silicon carbide fibers employing patented technology (US 5,759,688). Our CeraCarb™ materials offer outstanding performance in oxidizing atmospheres.

The oxidation resistance has been achieved through the combined use of the Silicon Carbide (SiC) fibers on an oxidation inhibitive matrix and the final SiC coating. One of the key inventive steps solved by BUFC engineers was matching the CTEs of the various components of the system.



Coatings

Specialist coatings provide solutions.

The development of carbon fiber reinforced composites has necessitated the development of a range of specialist coatings.

HITCO has developed a range of coatings to protect and enhance the properties of basic C/C. Included here are metallic coatings designed to seal and provide very low friction to Carbon/Carbon.

Ceramic type coatings (e.g. Silicon Carbide (SiC) have also been developed to provide oxidation resistance. Pyrolytic carbon coatings have been produced to provide sealing of the porous carbon surfaces.

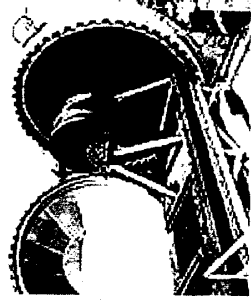
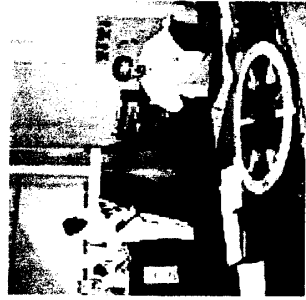


Rocket Motor Nozzles

When experience counts... we're the largest independent Rocket Motor Nozzle manufacturer in the U.S.

In an industry with zero tolerance for error, experience and performance mean everything. HITCO has what it takes with over 35 years of experience in the manufacture of large composite structures.

We are the largest independent producer of solid rocket motor nozzle assemblies in the United States. Our proven production experience is used on Delta II, III, and IV series of satellite launch vehicles for Boeing, Titan IV (SRMU) for Lockheed Martin, as well as Trident D-5, Lockheed Launch Vehicle (LLV) and Minuteman series motors.





HITCO CARBON COMPOSITES, INC.



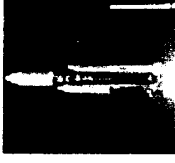
Concurrent Engineering Includes Customers and Suppliers:

Our design process begins with the use of concurrent engineering tools such as Quality Function Deployment (QFD) to ensure a complete understanding of customer requirements. Then, using state-of-the-art CAD tools, our team translates design requirements into reliable tooling and processes that focus on minimizing manufacturing cycle time, defects and scrap. The results of our efforts are high-quality, dependable, and robust composite structures.

Our supplier teammates, involved from the very beginning, provide valuable design input and raw material planning. This ensures quality, on-time delivery to our component and assembly manufacturing teams.

Our goal is to take the worry out of composites manufacturing by employing world class manufacturing techniques such as: concurrent engineering, supplier partnerships, effective process and quality control systems, and responsive customer service.

In the end, all of our products are manufactured with the care and expertise expected of the largest independent rocket motor nozzle manufacturer in the U.S.

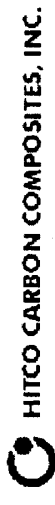


Propulsion

Over 35 years of experience...

The science of rocket propulsion can be traced back as far as AD 1232 when the ancient city of Kaifeng in China was reportedly protected from the Mongols by the use of rockets. Needless to say, rocket propulsion has advanced leaps and bounds since. Over the past century rocket propulsion has contributed to placing the first man on the moon to the delivery of modern day wireless communications systems.

HITCO is proud to be a part of propulsion science history. **HITCO** has over 35 years of experience in the manufacture of composite structures for rocket propulsion. Our expertise in composite material science has helped to make us the largest independent producer of solid rocket motor nozzle assemblies in the U.S. Whether it's a rocket motor nozzle, heat shield or flexseal, **HITCO** is capable of turning our customer requirements into the best product solution. Our proven production experience has been at work in such programs as Delta II, III and IV, Titan IV, Trident D-5, Lockheed Launch Vehicle (LLV) and Minuteman series of rocket motors.



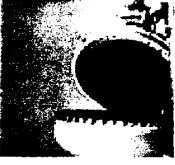
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- CERACARB® Products
- CHEMCARB™ Carbon/Carbon Composites
- MICROCARB® Microfiltration Media
- REFRASIL® Silica-Based Insulation Products
- SEMICARB® Semiconductor Furnace Insulation



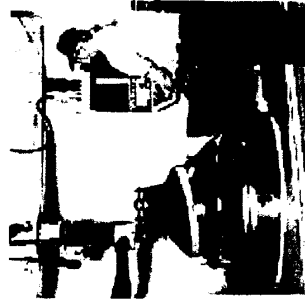
Autoclave Services

Large scale autoclave services

HITCO offers large scale autoclave services in an ISO 9001 manufacturing environment.

A range of autoclave and hydroclave capabilities are maintained at the **HITCO** facility in Los Angeles county.

Hitco can also provide lay-up, bonding, bagging, inspection, and machining expertise in a number of advanced composite materials and metals.



Equipment Capabilities

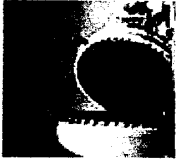
Our engineered composites manufacturing facilities include some of the world's largest autoclaves and hydroclaves as well as precision CNC machines.



Autoclaves

Autoclave	Pressure	Temperature	Dia x Length
1	205 psig (1413 kPa)	450°F (232°C)	65 in x 144 in (1.65 m x 3.66 m)
10	300 psig (2069 kPa)	500°F (260°C)	84 in x 120 in (2.13 m x 3.05 m)
11	300 psig (2069 kPa)	350°F (177°C)	84 in x 240 in (2.13 m x 6.10 m)
12	300 psig (2069 kPa)	625°F (329°C)	120 in x 130 in (3.05 m x 3.30 m)
13	270 psig (18629 kPa)	650°F (343°C)	176 in x 480 in (4.47 m x 12.19 m)





Hydroclaves

Hydroclaves	Pressure	Temperature	Dia x Length
7	1000 psig (6895 kPa)	350°F (177°C)	56 in x 75 in (1.42 m x 1.91 m)
9	1000 psig (6895 kPa)	350°F (177°C)	116 in x 120 in (2.95 m x 3.05 m)



Machines

Machine Tool Mfr	Type	Swing	Height
G&L #1 N/C	Vertical Turret Lathe	120 in (3.05 m)	110 in (2.79 m)
G&L #2 N/C	Vertical Turret Lathe	72 in (1.83 m)	72 in (1.83 m)
G&L #3 N/C	Vertical Turret Lathe	120 in (3.05 m)	119 in (3.02 m)
G&L #4 N/C	Horizontal Boring Mill	108 in (2.74 m)	120 in (3.05 m)
Binns and Berry (2 ea)	Horizontal Lathe	34 in (.864 m)	81 in (2.06 m)
Binns and Berry	Horizontal Lathe	34 in (.864 m)	120 in (3.05 m)



X-Ray capabilities

Our advanced radiographic facility is capable of standard and real-time radiography. Model 1000A

Linatron Linear Accelerator Seifert 420 x-ray machine

- 2 million and 6 million electron volt sources (1000A)
- 30 to 420 kilovolt source (Seifert)
- Film and computer automated realtime radiography
- Capable of penetrating fifty (50) inches of carbon and suitable for thin wall structures
- Capable of meeting stringent aerospace x-ray quality requirements



REFRASIL® Silica-Based Insulation Products

REFRASIL® Silica-Based Woven Textile products have been specifically designed for high temperature use.

REFRASIL® products are amorphous silica woven fabrics, textiles, non-woven blankets, and bulk fiber and fibers designed for high temperature use.

The **REFRASIL®** product line is available in a variety of product forms: Woven Fabrics, Woven Tapes, Non-woven Blankets, Bulk Fiber, Modules, Papers, Braiding Yarns, and other specialty forms such as Sleaving, Rope Gasket, and Cord.



HITCO CARBON COMPOSITES, INC.



REFRASIL® textiles provide excellent thermal and acoustic protection. These high-temperature resistant textiles products insulate and provide continuous protection in environments up to 1800°F (982°C), while maintaining their strength and flexibility.

- **REFRASIL®** “Irish” Woven Fabric contains a special coating that provides exceptional functioning when higher temperature performance, up to 2300°F (1260°C), is required
- **REFRASIL®** Non-woven Felts are available in a specially processed version that provides higher resistance to residual shrinkage (<1%) and degradation in extreme environments.
- **REFRASIL®** products can withstand excursions to 3100°F (1704°C) with minimal embrittlement and shrinkage.
- **REFRASIL®** products are available in > 96% silica content. They resist oxidation, most corrosive solutions and chemicals, and they present no known health hazard.
- Applications for **REFRASIL®** products range from welding blankets to satellite shrouds, firewalls to aircraft insulation, furnace curtains to thermal couple insulation wrap.



Features:

- Asbestos Replacement
- Resilient Fireproof High Temperature Insulator
- Resists Molten Metals and Radiant Heat
- Compatible with Most Chemicals
- Low Halogen Content
- High Dielectric Strength
- Minimal Smoke Emission
- Low Thermal Conductivity
- No Known Health Hazards
- Amorphous Structure
- Cost Effective

Application Guide:

Maintenance and energy costs are reduced by using **REFRASIL®** products in applications and industries where equipment downtime and fuel conservation are primary considerations. Some of these industries include shipbuilding and repair, power plants and utilities, metal fabrication, foundries, petroleum and petrochemical plants, chemical processing, nuclear energy, glass plants, appliance manufacturing, aircraft and aerospace, electronics and communications, heat treating and other areas where thermal insulation is essential to performance, safety and cost.

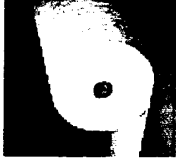
Product Descriptions:

Please refer to our product sheets for more specific information about our **REFRASIL®** woven products.





HITCO CARBON COMPOSITES, INC.



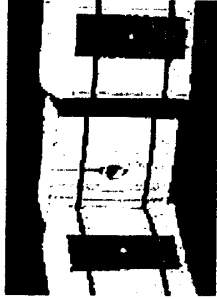
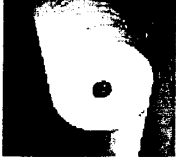
REFRASIL® Needle Blanket Insulation

High Temperature Insulation Blankets made from Silica, Basalt, and Glass Fibers for your Thermal & Acoustic Challenges:

The **REFRASIL®** textile family includes a series of needled insulation blankets manufactured from a variety of fibers to meet your thermal and acoustic insulation requirements.

Our needled blanket products are recommended as cost-effective, health friendly, thermal solutions for temperatures ranging from 1100 °F to 2100 °F. These insulation blankets are manufactured from:

- High purity silica (99% silica) for temperatures up to 2100 °F
- Silica (93.5% silica) for temperatures up to 2000 °F
- Silica/Basalt blend for temperatures up to 1800 °F
- Basalt for temperatures up to 1500 °F
- Silica/Glass blends for temperatures up to 1500 °F
- Glass for temperatures up to 1100 °F



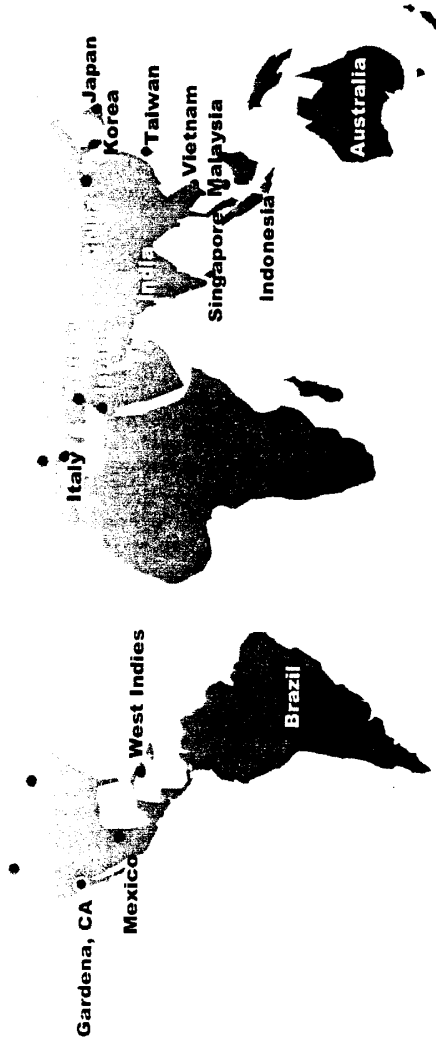
Our silica-based blankets are also available in pre-shrunk versions to eliminate in-situ shrinking (less than 0.7% shrinkage at 2000 °F). The low shrinkage blankets are also 3-4 times stronger than typical RCF blanket.

Our blankets offer several advantages over competing blanket insulation materials such as:

- Zero shot content (blanket contains no un-fiberized particles)
- Non-respirable (fiber diameter between 6 - 13 microns)
- Binder free
- Chemical resistant (silica and basalt blankets)
- Contains no asbestos
- Contains no ceramic refractory fiber (RCF)
- High strength
- Vibration resistant
- Erosion resistant
- Excellent acoustic properties (sound adsorption)
- Non water soluble

Product Descriptions:

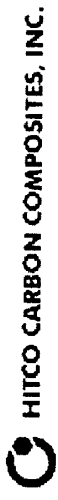
Please refer to our product sheets for more specific information about our REFRASIL® needled products



Sales Offices

Hitco Carbon Composites, Inc.
1600 West 135th Street
Gardena, CA 90249-2506
U.S.A.
Tel. (1) 310-527-0700
Fax (1) 310-516-5714

Worldwide Headquarters:
SGL Carbon AG
Rheingastr. 182
65203 Wiesbaden
Germany
Tel. (49) 611-6029-0
Fax (49) 611-6029-101



Career Opportunities

E-mail
Fax (310) 769-2107 or
(310) 970-5802

Diversity: A Foundation for Innovation

Networked across the globe, Hitco Carbon Composites values a diverse workforce, and is an equal opportunity employer. Employees give the organization the capability to provide superior products and services to the global market. We employ individuals from multiple disciplines, including technical, engineering, business, and science to develop extraordinary results. We offer a competitive compensation package coupled with an outstanding work environment.

Join our team!

We currently have no job openings at this time. Please check back with us periodically for new career opportunities.

Thank you for your attention in joining our team!

REFRASIL® Cloth

Refractory Silica Cloth Products



REFRASIL Cloth provides continuous protection up to 2300°F.

REFRASIL textiles are continuous filament, amorphous silica products with the thermal performance of a refractory material. The product is produced through the chemical leaching of specially formulated glass fibers. REFRASIL is >96% silica (SiO₂), resists oxidation and most corrosive solutions and presents no known health hazard. REFRASIL fiber diameters range from 8 to 10 microns.

REFRASIL textiles will not melt or vaporize until temperatures exceed 3100°F (1704°C). REFRASIL will insulate continuously and retain strength and flexibility up to 1800°F (982°C).

The most popular form of REFRASIL is woven cloth. REFRASIL cloths are available in a number of different weights and thicknesses.

These cloths come in standard (UC series) as well as pre-shrunk (C series) form. The cloths can also be treated for abrasion resistance (AR series) and continuous temperatures to 2300°F (Irish series). A cost-effective cloth, Welding Grade Cloth (WGC), is also available.

FEATURES:

- Asbestos replacement
- Resilient
- Fireproof
- High temperature insulator resists molten metals and radiant heat
- Compatible with most chemicals
- Low halogen content
- High dielectric strength
- Minimal smoke emission
- Low thermal conductivity
- No known health hazards
- Amorphous structure
- Cost Effective

AVAILABILITY - Standard roll size for all REFRASIL cloth is 50 lineal yards ±10% maximum length. No roll contains more than two pieces of fabric and no piece within the roll is less than 10 lineal yards. REFRASIL's textiles are available in a variety of product forms to suit each customer's specific needs-cloth, tape, sleeving, rope, yarn, cordage, batt and bulk fiber. All textiles can be purchased through a nationwide network of stocking distributors.



HITCO CARBON COMPOSITES, INC.

1600 West 135th St. • Gardena, CA 90249
www.hitco.com or www.refrasil.com
e-mail: refrasil@hitco.com
Tel: 800.421.5444 • 310.527.0700
Fax: 310.515.1779

REFRASIL® Cloth

Refractory Silica Cloth Products



REFRASIL Welding Grade Cloth (WGC) - is effective in applications such as welding blankets and screens, personnel protection shields, equipment protection, and stress relieving pads. WGC products have been specifically designed to provide the user with a cost-effective material for commercial and consumable welding applications. When used properly, WGC will protect personnel, equipment, and finishes from molten metal splatter and sparks. The high silica content makes WGC resistant to most chemicals and elements within the 1800°F temperature range. The products' low chloride content makes them suitable for welding stainless steels and ensures against chloride contamination.

WGC Series

Product Description	Product Code	Color	Nominal Thickness (in.)	Nominal Width (in.)	Weight oz/sq yd.
Standard	WGC-18	Tan	.030	36	18.0

Irish Series REFRASIL Cloth Extends Temperature Range to 2300° F. - Irish REFRASIL insulation cloth was developed to extend the temperature range and flexibility characteristics of REFRASIL textiles. The greenish color from which it derives the name Irish is the result of a special high-temperature treatment.

Irish REFRASIL insulation will withstand continuous temperatures to 2300°F with little or no change in properties.

Cloth is the standard form of Irish REFRASIL insulation, which is available in two versions, C1554 and 2221.

Irish REFRASIL 2221 has been treated with a coating for ease of handling and physical integrity during fabricating. Irish 2221 series REFRASIL cloth is also available as a 2 inch, or 4 inch, wide tape.

Irish Series

Product Description	Product Code	Color	Nominal Thickness (in.)	Nominal Width (in.)
Irish Cloth	C1554-48	Green	.026	33
	C1554-96	Green	.052	33
Treated	2221-48	Green	.026	33
Irish Cloth	2221-96	Green	.052	33

Standard UC100 and C100 Series Cloth Protect to 1800°F- REFRASIL standard woven fabric is known as the UC100 series cloth. UC cloths are identified by their tan color. The UC series cloths are available with the following coatings: Pressure sensitive adhesive, Silicone Rubber, Aluminum, Vermiculite, and Black Iron Oxide.

UC Series - Standard Cloth

Product Description	Product Code	Color	Nominal Thickness (in.)	Nominal Width (in.)	Weight oz/sq yd
Super Light	UC100-28	Tan	.015	36	10
Light	UC100-48	Tan	.030	36	18
Heavy	UC100-96	Tan	.056	36	36
Super Heavy	UC100-192SS	Tan	.060	36	40

The C series cloths - are pre-shrunk versions of the popular UC series cloth and is identified by its white color. The "Pre-shrunk" C series cloth is used in applications where shrinkage cannot be tolerated.

C Series - PreShrunk Cloth

Product Description	Product Code	Color	Nominal Thickness (in.)	Nominal Width (in.)	Weight oz/sq yd
Light	C100-48	White	.028	33	18
Heavy	C100-96	White	.056	33	35

Abrasion-Resistant AR100 Series Provides Improved Abrasion Resistance and Strength - The AR series REFRASIL is coated with a specially formulated coating, making it more abrasion resistant than standard UC series cloth. The AR series REFRASIL is recommended for use in high traffic areas and for fabrication because the coating resists minor damage from dragging, scraping, tearing and snagging. The coating also provides greater seam strength than standard UC series REFRASIL cloth making it an excellent choice as a high temperature fabrication cloth. The AR series REFRASIL is identified by its orange coating. Although there will be a loss of coating from exposure to high temperatures, only the abrasion resistance of the fabric will be affected, not its overall thermal performance.

AR Series - Abrasion Resistant Cloth

Product Description	Product Code	Color	Nominal Thickness (in.)	Nominal Width (in.)	Weight oz/sq yd
Light	AR100-48	Orange	.032	36	20
Heavy	AR100-96	Orange	.056	36	40



WITCO CARBON COMPOSITES, INC.

8/1/01

Page 2 of 2

REFRASIL[®] Rope Gasket & Sleeving

Rope Gasket & Sleeving Products



Rope Gasket Sealing Material for Temperatures up to 1800°F (982°C)

REFRASIL Rope Gasket is a dimensionally controlled, high-density, braided, high silica (<96% SiO₂) product intended for service temperatures up to 1800°F (982°C).

Produced in five sizes - 1/4" through 1" diameter REFRASIL Rope Gasket is braided from texturized yarns, pre-shrunk, and treated with a hydrocarbon finish to improve its abrasion resistance and ease of handling.

Availability - REFRASIL's textiles are available in a variety of product forms to suit each customer's specific needs: cloth, tape, sleeving rope, yarn, cordage, batt and bulk fiber.

All textiles can be purchased through a nationwide network of stocking distributors.

Rope Gasket Properties

Product Code	Nominal Diameter (in.)	Density (lbs./cu.ft.)	Yield (ft./lb.)	Breaking Strength Ambient Temp. (lbs.)	Shrinkage At 1600°F (%)
RG-1/4	.23	44	82	40	.06
RG-3/8	.33	45	38	60	.06
RG-1/2	.47	31	24	140	.06
RG-3/4	.73	31	11	250	.07
RG-1	.96	36	6	470	.08

Packaging - REFRASIL RG-1/4, RG-3/8 and RG-1/2 are packaged as 100 lineal feet spools, two spools to a carton. RG-3/4 and RG-1 are packaged as 50 lineal feet spools, two spools to a carton.

Typical Applications - REFRASIL Rope Gasket can be used where compact, dense, high-temperature performance compressive seals are required, e.g., partial grooves in furnace or oven doors where the rope is not entirely contained. It also is used as a sealing element in many types of manufacturing equipment which handle heat, such as furnaces, boilers and ovens.

In small-diameter high-temperature gasketing applications, REFRASIL Rope Gasket is an excellent alternative to asbestos and ceramic fiber-braided ropes and wicks.

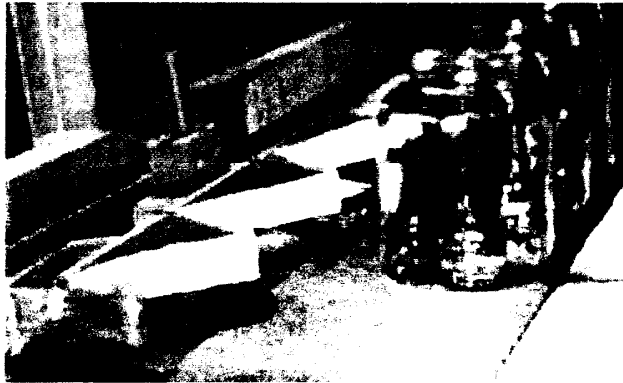


HITCO CARBON COMPOSITES, INC.

1600 West 135th St. • Gardena, CA 90249
www.hitco.com or www.refrasil.com
e-mail: refrasil@hitco.com
Tel: 800.421.5444 • 310.527.0700
Fax: 310.515.1779

REFRASIL[®] Rope Gasket & Sleeving

Rope Gasket & Sleeving Products



— REFRASIL heavy wall sleeving (HWS-1) covering assembly line equipment components provides protection against contamination and marking of hot glass containers.

— REFRASIL sleeving insulates blast furnace water cooling hoses in steel mill.



REFRASIL Asbestos-Free Textiles are Designed To Perform Continuously to 1800°F (982°C)

REFRASIL industrial insulation textiles are pure silica products with the high-performance capabilities of a refractory material. They provide insulation and protection in continuous environments to 1800°F (982°C), retaining their original textile characteristics. REFRASIL is relatively inert and resists most chemical attack. It provides outstanding protection in electrical insulation applications with good dielectric strength of 40 volts/mil of thickness.

With REFRASIL textiles, maintenance time, labor, and energy costs can be reduced. Parts, materials, equipment, personnel, and machinery can be protected from potential damage and destruction caused by molten metal splash, sparks, and radiant heat.

Sleeving Does Not Lose Strength and Remain Flexible to 1800°F - REFRASIL Braided Sleeving is the solution for an efficient, low maintenance thermal insulation. Absolutely fireproof, it is also resistant to oxidation and most corrosive solutions, and does not degrade in the presence of water.

REFRASIL Sleeving is available as standard or heavy wall. The looser braid of standard sleeving can accommodate a large variety of diameters. Heavy wall sleeving has a very tight and thicker braid for maximum thermal protection.

Sleeving Properties

Product	Code	Nominal I.D. (in.)	Maximum I.D. (in.)
Standard	UB-3/4	3/4	0.95
	UB-1	1	1.35
Nominal Wall Thickness - .032 in	UB-1-1/2	1-1/2	2.50
	UB-2	2	3.20
	UB-2-1/2	2-1/2	3.30
	HWS-3/8	3/8	.040
Heavy Wall	HWS-1/2	1/2	.060
Nominal Wall Thickness-.065 in.	HWS-1	1	1.10
	HWS-1-1/2	1-1/2	1.60

Packaging- REFRASIL Sleeving products are typically packaged as 50 lineal feet spools.

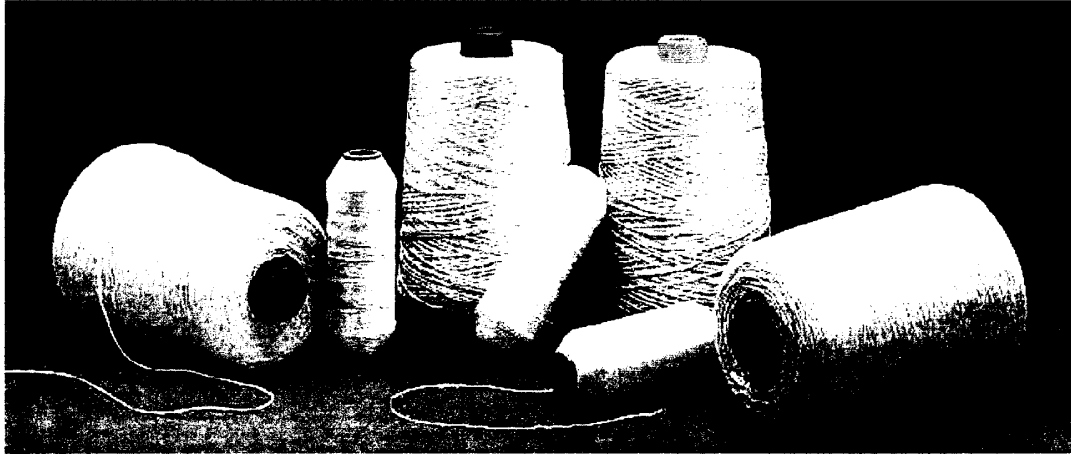


HITCO CARBON COMPOSITES, INC.

1600 West 135th St. • Gardena, CA 90249
 www.hitco.com or www.refrasil.com
 e-mail: refrasil@hitco.com
 Tel: 800.421.5444 • 310.527.0700
 Fax: 310.515.1779

REFRASIL® Cordage & Yarn

Cordage & Yarn Products



REFRASIL Cordage and Yarn Insulate Against High Temperatures

REFRASIL textiles are continuous filament, amorphous silica products, with the thermal performance of refractory materials. The fiber is highly porous and does not melt or vaporize until temperatures exceed 3100°F (1704°C). REFRASIL Cordage and Yarn textiles will operate continuously at temperatures up to 1800°F (982°C) with little or no change in properties because they have been fired at 1800°F.

These products have excellent resistance to thermal shock, as well as minimal shrinkage at service temperatures. They provide reliable insulation and protection while retaining their original textile characteristics.

REFRASIL is relatively inert and resists most chemical attack. It provides outstanding protection in electrical insulation applications with good dielectric strength of 40 volts/mil of thickness.

C-series cordage and yarn are PTFE lubricated to facilitate handling and improve their abrasion resistance. If requested, cordage and yarn can be supplied with heavy PTFE or without lubrication.

AVAILABILITY - REFRASIL's textiles are available in a variety of product forms to suit each customer's specific needs-cloth, tape, sleeving, rope, yarn, batt and bulk fiber.

All textiles can be purchased through a nationwide network of stocking distributors.

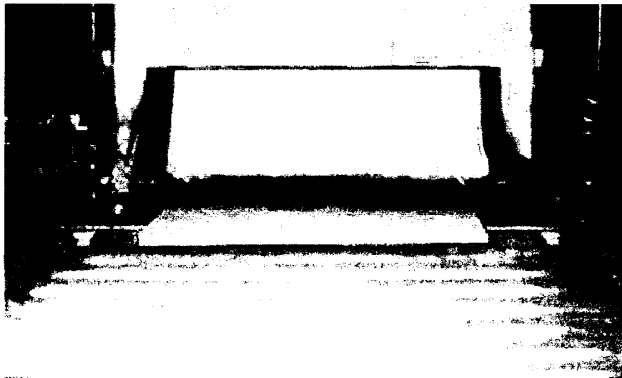


HITCO CARBON COMPOSITES, INC.

1600 West 135th St. • Gardena, CA 90249
www.hitco.com or www.refrasil.com
e-mail: refrasil@hitco.com
Tel: 800.421.5444 • 310.527.0700
Fax: 310.515.1779

REFRASIL® Cordage & Yarn

Cordage & Yarn Products



— Steel sheet annealing furnace curtain is made up of multiple rows of REFRASIL cordage in a mop-like fashion to reduce heat loss and fuel requirements.

The mop curtain → allows full penetration into the continuous furnace.



Special Benefits - REFRASIL Cordage used in "mop-type" curtains at entrances and exits of continuous belt treating furnaces will protect parts and products against contamination and marking damage during high heat processing. REFRASIL resists oxidation, most corrosive solutions and chemicals. REFRASIL textile products have a high capacity to absorb moisture but do not degrade in the presence of water.

With REFRASIL textiles on the job, maintenance time and labor costs can be reduced, energy cost cut, and parts, materials, men and machinery protected from potential damage and destruction caused by molten metal splash, sparks, and radiant heat.

REFRASIL includes a complete range of textile forms for protection against all these adverse conditions. And they're all non-asbestos materials.

Cordage and Yarn Properties

Product Code	Nominal Diameter (in.)	Nominal Breaking Strength (lb.)	Lineal Nominal Yield (yd./lb.)	Shrinkage At 1800°F (%)	Ply Count*
YARN					
FYT-100-Z	.020	3.0	3280	3.7	5
C-SERIES CORDAGE					
C-100-3	.040	11.8	700	3.1	8
C-100-4	.053	13.0	330	5.0	16

* 4 strands per ply, 204 filaments per strand.

Packaging-REFRASIL Cordage is available on 6-1/2" spools or 3" x 10" cores. Approximate weight of cordage in a standard package is 1.50 pound; 3" x 10" braider tube is 3.0 pounds.

REFRASIL Yarn is wound on 4-1/2" braider tubes, (5/8" I.D. and 21/5 O.D.), taper end and covered with a polyethylene film. Net weight of a package is approximately .25 pound.

Typical Applications-Cordage and yarn can be braided onto or around thermocouple wires, instrument elements, electrical cables, electrical cable harnesses and hoses.

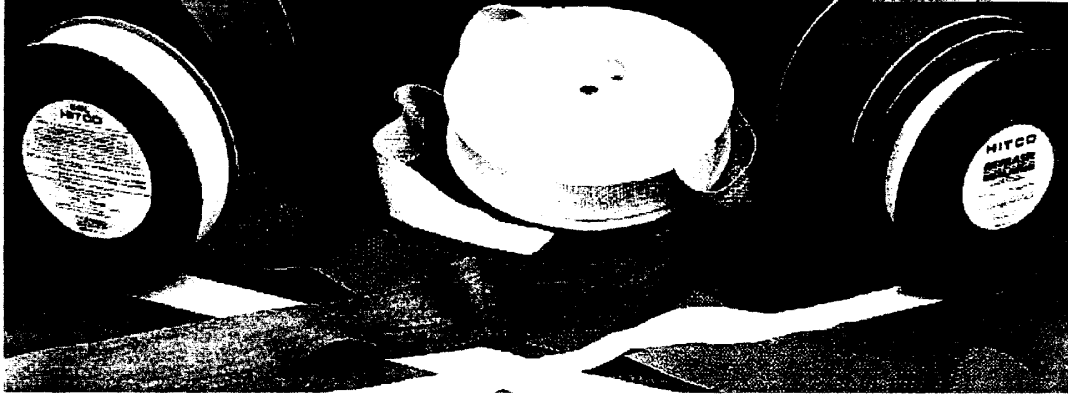


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 www.hitco.com or www.refrasil.com
 e-mail: refrasil@hitco.com
 Tel: 800.421.5444 • 310.527.0700
 Fax: 310.515.1779

REFRASIL[®] Tape

Woven • Wide woven • Slit



REFRASIL Woven, Wide Woven and Slit Tapes Proven in Numerous Applications Involving Thermal Insulation, Energy Savings, Safety and Electrical Insulation.

With a long service life and greater thermal performance than other textiles, REFRASIL tapes lower your maintenance cost and provide high performance protection. In addition, REFRASIL's excellent dielectric strength makes it an outstanding high-temperature electrical insulator, while its chemical properties contribute to its resistance to oxidation and attack by most corrosive solutions.

Standard REFRASIL tapes are high silica (>96% SiO₂) products intended for high temperature applications with continuous service up to 1800°F (982°C). Woven tape is available in "pre-shrunk" form, which is fired at 1800°F to reduce any further shrinkage in the service applications. Wide woven tape in thicknesses of .060" and .125" is produced as standard REFRASIL and is subject to shrinkage when exposed to sustained temperatures above 1800°F.

Irish REFRASIL extends the stability and flexible characteristics of standard REFRASIL slit tapes to 2300°F (1260°C). High excursion temperatures or "spikes" over 2000°F (1093°C) may cause embrittlement, but the REFRASIL continues to insulate. REFRASIL is relatively inert and resists most chemical attack. It provides outstanding protection in electrical insulation applications with good dielectric strength of 40 volts/mil of thickness.

REFRASIL includes a complete range of textile forms for protection against all these adverse conditions. And they're all non-asbestos materials.

Typical Applications -

- Mop Curtains for continuous belt furnaces
- Electrical lead wire insulation
- Welding blanket edge & seam binding
- Cooling hose wrap insulation
- Instrumentation wire insulation
- Power cable insulation

Packaging -

REFRASIL tape products are packaged as 50 or 100 lineal feet spools depending on type and thickness.

Availability -

REFRASIL's textiles are available in a variety of product forms to suit each customer's specific needs - cloth, tape, sleeving, rope, yarn, cordage, batt and bulk fiber. All textiles can be purchased through a nationwide network of stocking distributors.



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1600 West 135th St. • Gardena, CA 90249
www.hitco.com or www.refrasil.com
e-mail: refrasil@hitco.com
Tel: 800.421.5444 • 310.527.0700
Fax: 310.515.1779

REFRASIL[®] Tape

Woven • Wide woven • Slit



← REFRASIL Irish slit tape is spiral wrapped around water cooled skid pipe in steel mill slab reheat furnace, securing REFRASIL RB1800 blanket insulation, providing protection in environments up to 2300°F.

Adhesive backed → REFRASIL UT series slit tape makes application quick and easy.



Woven Tape Properties

Product Description	Product Code	Nominal Thickness (in.)	Nominal Width (in.)
Standard Tape*	UT100-1	.015	1
	UT100-1-1/2	.015	1-1/2
Pre-shrunk**	TF100-1	.015	1
	TF100-1-1/2	.015	1-1/2

*Nominal tape roll size 285 ± 10% lineal feet

** Nominal tape roll size 265 ± 10% lineal feet

Wide Woven Tape Properties

Product Description	Product Code	Nominal Thickness (in.)	Nominal Width (in.)
Standard Tape*	UT100-41	.060	1
	UT100-42	.060	2
	UT100-44	.060	4
	UT100-46	.060	6
Standard Tape**	UT100-81	.125	1
	UT100-82	.125	2
	UT100-84	.125	4
	UT100-86	.125	6

*Nominal tape roll size 285 ± 10% lineal feet

** Nominal tape roll size 265 ± 10% lineal feet

Slit Tape Properties

Product Description	Product Code	Nominal Thickness (in.)	Nominal Width (in.)
Standard Tape (w/adhesive)	UT48-2	.026	2
	UT48-4	.026	4
	UT96-2	.050	2
	UT96-4	.050	4
Abrasive Res. Tape (sealed edges)	AR48-2	.033	2
	AR48-4	.033	4
	AR96-2	.060	2
Irish Tape	AR96-4	.060	4
	2221-96-2	.052	2
	2221-96-4	.052	4

Available in rolls 100 ± 10% lineal feet. No roll contains more than 3 pieces with single pieces not less than 20 lineal feet.

Slit tapes are produced from Standard UC Series, AR Series, and Irish REFRASIL cloth. A standard 50 LY roll can be custom slit to any specified width for a special handling charge. Stock widths are 2" and 4". Standard tape is slit from UC Series cloth coated one side with pressure-sensitive adhesive protected by a release paper cover. The adhesive provides an aid to applying the tape in various field and shop conditions. Abrasion resistant AR Series and Irish slit tape have no adhesive; the edges are sealed with a refractory coating to prevent unraveling.



HITCO CARBON COMPOSITES, INC.

1600 West 135th St. • Gardena, CA 90249
 www.hitco.com or www.refrasil.com
 e-mail: refrasil@hitco.com
 Tel: 800.421.5444 • 310.527.0700
 Fax: 310.515.1779

REFRASIL[®] HITCO's alternative fiber

High Temperature Insulation



REFRASIL RB1800 and RB2000 are amorphous silica fiber based products that are shot free and binder free. These high strength materials provide long-term thermal and acoustic insulation for applications in the range of 1800° - 2200°F. The products are non-hazardous since they contain no asbestos, no refractory ceramic fiber (RCF), or any respirable fiber below 6 microns in diameter. REFRASIL RB1800 and RB2000 products provide effective solutions to a wide variety of thermal and acoustic management problems while helping to maintain a health hazard free environment.

REFRASIL RB1800 products are comprised of high-purity, high strength amorphous silica fibers between 6-13 microns in diameter and 2-4" in length. These long fibers are needled into high strength products that are capable of unequalled performance in high-purity, high-temperature applications where contamination cannot be tolerated. The physical strength, erosion resistance, and resistance to vibrational degradation make these materials superior to refractory ceramic fiber insulation blankets in challenging applications. The silica fibers that make up REFRASIL RB1800 products are resistant to most chemicals and harsh atmospheres, especially those that are acidic.

REFRASIL RB2000 is a "Low Residual Shrinkage" blanket that is specially treated to eliminate almost all residual shrinkage up to 2150°F. REFRASIL RB2000 also possesses approximately three times the strength of standard RB1800 and RCF products, while maintaining its resiliency.

REFRASIL RB1800 and RB2000 blankets are available in a variety of thicknesses, widths, and densities to meet the most demanding thermal and acoustical insulation requirements. Bulk fiber, silica fiber paper and silica fiber modules are also available.

TYPICAL APPLICATIONS:

- Glass furnace crown insulation repair
- Nuclear insulation applications
- Acoustic insulation
- Insulating pads and blankets
- High temperature & acid resistant gaskets
- Exhaust manifold insulation
- Stress relieving pads
- High temperature pipe and valve insulation
- Investment casting mold wrap
- Fire protection
- Muffler packing
- Heat treating furnace linings
- Petro-chemical process heater linings
- Welding protection
- Furnace, kiln, incinerator, and boiler linings
- Thermal & acoustic insulation for steam and gas turbines
- Roller hearth furnace linings
- Soaking pit & pre-heat furnace linings and seals
- Expansion joint and packing material



Bulk Fiber Blankets Paper Modules

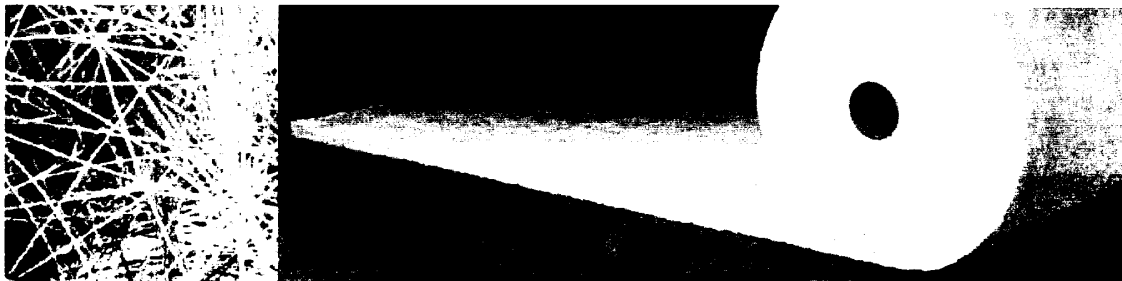


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1600 West 135th • Gardena, CA 90249
www.hitco.com or www.refrasil.com
e-mail: refrasil@hitco.com
Tel: 800.421.5444 • 310.527.0700
Fax: 310.515.1779

REFRASIL[®] BLANKET 1800 (RB1800)

High Temperature Blanket Insulation



DESCRIPTION – REFRASIL[®]
BLANKET 1800 is a lightweight, high temperature insulation composed of 100% amorphous silica fiber that has the following unique physical properties:

- Zero shot content
- Binder free
- Outstanding chemical resistance – especially acids and acidic vapors
- Contains no asbestos or refractory ceramic fiber (RCF)
- Excellent sound absorption
- Highly resilient.
- Not soluble in water or oil
- Non-respirable
- Outstanding resistance to vibrational degradation
- Increased strength with Temperature

STANDARD SIZES

Thickness	Roll Width
1/8" (3mm)	36" (92cm)
1/4" (6mm)	36" (92cm)
1/2" (12mm)	36" (92cm)
1" (25mm)	36" (92cm)

* Special sizes available upon request

DENSITY

9.0 - 10.5 lbs./ft.³ (144 - 168 kg/m³)

FIBER PROPERTIES

Fiber diameter: 6-13 microns
Fiber length: 2" - 4" avg. (50-102 mm)

The test data shown are based on average results on production samples and are subject to normal variation on individual tests. Therefore, the above listed data should not be taken as established maximum or minimum specifications. For technical support or specific application information, contact the HITCO Carbon Composites Materials & Fabrication Department at (800) 421-5444, or visit our website at www.hitco.com

Revised 4/9/01

MAXIMUM CONTINUOUS USE TEMPERATURE

For continuous use: 1800° F (980° C)
Melting point: 3100° F (1700° C)

TENSILE STRENGTH (ASTM C686)

250 Grams / gram (1 inch material)

CHEMICAL ANALYSIS

Silica (SiO ₂)	-	93.5% minimum
Alumina (Al ₂ O ₃)	-	4.0%
Sodium (Na ₂ O)	-	0.8%
Calcium Oxide (CaO)	-	0.8%
Others	-	1.0%

PERMANENT LINEAR CHANGE (ASTM C356)

	% shrinkage
24 hrs. at 1000° F (540° C)	- 3.00%
24 hrs. at 1200° F (650° C)	- 4.00%
24 hrs. at 1400° F (760° C)	- 6.50%
24 hrs. at 1600° F (870° C)	- 6.50%
24 hrs. at 1800° F (980° C)	- 6.50%
24 hrs. at 2000° F (1090° C)	- 8.00%

THERMAL CONDUCTIVITY (ASMT C177)

Mean Temperature	Btu-in./hr.ft. ² °F
400° F (200° C)	0.36
750° F (400° C)	0.59
1100° F (600° C)	0.93
1500° F (820° C)	1.39
1800° F (980° C)	1.93



HITCO CARBON COMPOSITES, INC.

1600 West 135th • Gardena, CA 90249
www.hitco.com or www.refrasil.com
e-mail: refrasil@hitco.com
Tel: 800.421.5444 • 310.527.0700
Fax: 310.515.1779

REFRASIL[®] BLANKET 2000 (RB2000)

High Temperature Blanket Insulation



DESCRIPTION – REFRASIL[®]

BLANKET 2000 is a lightweight, high temperature, insulation composed of 100% amorphous silica fiber that has been specially treated during the manufacturing process to reduce residual shrinkage at elevated temperatures. It has the following unique properties:

- Zero shot content
- Binder free
- Outstanding chemical resistance – especially acids
- Contains no asbestos or refractory ceramic fiber
- Excellent sound absorption
- Highly resilient
- Not water soluble
- Low Shrinkage
- Non-respirable

STANDARD SIZES

Thickness	Roll Width
1/8" (3mm)	33" (≈84cm)
1/4" (6mm)	33" (≈84cm)
1/2" (12mm)	33" (≈84cm)
1" (25mm)	33" (≈84cm)

* Special sizes available upon request

DENSITY

10.5 – 12.0 lbs./ft³ (168 – 192 kg/m³)

FIBER PROPERTIES

Fiber diameter: 6-13 microns

Fiber length: 2" - 4" avg. (50-102 mm)

The test data shown are based on average results on production samples and are subject to normal variation on individual tests. Therefore, the above listed data should not be taken as established maximum or minimum specifications. For technical support or specific application information, contact the HITCO Carbon Composites Materials & Fabrication Department at (800) 421-5444, or visit our website at www.hitco.com

MAXIMUM RECOMMENDED USE TEMPERATURE

For intermittent use:	2200° F (1200° C)
For continuous use:	2000° F (1090° C)
Melting point:	3100° F (1700° C)

TENSILE STRENGTH (ASTM C686)

	lbs./in ²	Kg/cm ²
For 1/8" thick blanket	TBD	TBD
For 1/4" thick blanket	TBD	TBD
For 1/2" thick blanket	TBD	TBD
For 1" thick blanket	TBD	TBD

CHEMICAL ANALYSIS

Silica (SiO ₂)	- > 93.5% min
Alumina (Al ₂ O ₃)	- 4.0%
Others	- < 1.0%

PERMANENT LINEAR CHANGE (ASTM C356)

	% shrinkage
24 hrs. at 1000° F (540° C)	0.05%
24 hrs. at 1200° F (650° C)	0.06%
24 hrs. at 1400° F (760° C)	0.06%
24 hrs. at 1600° F (870° C)	0.10%
24 hrs. at 1800° F (980° C)	0.30%
24 hrs. at 2000° F (1090° C)	0.70%

THERMAL CONDUCTIVITY (ASTM C177)

Mean Temperature	Btu-in./hr.ft. ² °F	Kcal-m/hr.sq.m °C
500° F (260° C)	0.45	0.054
1000° F (540° C)	0.78	0.094
1500° F (820° C)	1.39	0.166
1800° F (980° C)	1.93	0.231



HITCO CARBON COMPOSITES INC.

1600 West 135th • Gardena, CA 90249
www.hitco.com or www.refrasil.com
e-mail: refrasil@hitco.com
Tel: 800.421.5444 • 310.527.0700
Fax: 310.515.1779

Revised 4/24/01

REFRASIL® SILICA FIBER PAPER (SFP)

High Temperature Paper Insulation



DESCRIPTION – REFRASIL® Silica Paper is a lightweight, high temperature, insulation composed of amorphous silica fiber. It has the following unique properties:

- Zero Shot Content
- Outstanding chemical resistance - especially acids
- Contains no asbestos or refractory ceramic fiber (RCF)
- Highly Resilient
- Higher Strength Insulating Material
- Non-respirable Fiber
- Electrically Insulating
- Less Abrasive to Die Cutting Tools

STANDARD SIZES

Thickness – 1/16", 1/8"
Roll widths – 12", 24", 36"

DENSITY

7-8 pcf
112-128 kg/m³

FIBER PROPERTIES

Fiber diameter: 6-13 microns
Fiber length: 0.25 – 0.5" avg. (6-12 mm)

LOI

-Moisture ~10%
-Binder 5%

MAXIMUM RECOMMENDED USE TEMPERATURE

For intermittent use: 2200° F (1200° C)
For continuous use: 1800° F (980° C)
Melting point: 3100° F (1700° C)

TENSILE STRENGTH (T.A.P.P.I. 494)

Thickness	Direction	
	Machine	Cross
Nominal	g/in	g/in
1/16"	8500	3700
1/8"	12000	5300

CHEMICAL ANALYSIS

Silica (SiO₂) - > 93.5% min
Alumina (Al₂O₃) - 4.0%
Others - < 1.0%

THERMAL CONDUCTIVITY

Temperature	Btu in/hr ft ² °F	W/mK
400°F (200 °C)	0.30	0.043
750 °F (400 °C)	0.46	0.066
1100 °F (600 °C)	0.70	0.101
1500 °F (820 °C)	0.94	0.135
1800 °F (980 °C)	1.05	0.151

PERMANENT LINEAR CHANGE (ASTM C356)

	% shrinkage
24 hrs at 1000 °F (540° C)	3.90%
24 hrs at 1400 °F (760° C)	5.00%
24 hrs at 1800 °F (980° C)	5.33%

The test data shown are based on average results on production samples and are subject to normal variation on individual tests. Therefore, the above listed data should not be taken as established maximum or minimum specifications. For technical support or specific application information, contact the HITCO Carbon Composites Materials & Fabrication Department at (800) 421-5444, or visit our website at www.hitco.com

Revised 11/13/01



HITCO CARBON COMPOSITES, INC.

1600 West 135th • Gardena, CA 90249
www.hitco.com or www.refrasil.com
e-mail: refrasil@hitco.com
Tel: 800.421.5444 • 310.527.0700
Fax: 310.515.1779

REFRASIL® BULK FIBER

(RBF)

High Temperature Bulk Fiber Insulation



DESCRIPTION – REFRASIL® BULK FIBER (RBF) is a lightweight, high temperature, bulk fiber insulation composed of 100% amorphous silica fiber. It has the following unique physical properties:

- Zero shot content
- Binder free
- Outstanding chemical resistance – especially acid
- Contains no asbestos or refractory ceramic fiber (RCF)
- Excellent sound absorption
- Not water soluble
- Non-respirable

STANDARD PACKAGING

25 lb. (11.3 kg.) containers

FIBER PROPERTIES

Fiber diameter: 6-13 microns

Fiber length: 2" - 4" avg. (50-102 mm)

*Special lengths available upon request.

MAXIMUM RECOMMENDED USE TEMPERATURE

For intermittent use: 2000° F (1090° C)

For continuous use: 1800° F (980° C)

Melting point: 3100° F (1700° C)

THERMAL CONDUCTIVITY (ASTM C177)

Mean Temperature	Btu-in./hr.ft. ² °F	Kcal-m/hr.sq.m °C
500° F (260° C)	0.45	0.054
1000° F (540° C)	0.78	0.094
1500° F (820° C)	1.39	0.166
1800° F (980° C)	1.93	0.231

CHEMICAL ANALYSIS

Silica (SiO ₂)	- > 93.5% min
Alumina (Al ₂ O ₃)	- 4.0%
Others	- < 1.0%

The test data shown are based on average results on production samples and are subject to normal variation on individual tests. Therefore, the above listed data should not be taken as established maximum or minimum specifications. For technical support or specific application information, contact the HITCO Carbon Composites Materials & Fabrication Department at (800) 421-5444, or visit our website at www.hitco.com

Revised 04/24/01



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www.hitco.com or www.refrasil.com
e-mail: refrasil@hitco.com
Tel: 800.421.5444 • 310.527.0700
Fax: 310.515.1779