

行政院及所屬各機關出國報告
(出國類別： 考察)

(薄膜塗佈機之研究)

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出國地區：美國
出國期間：89.10.19~89.10.27
報告日期：90.02.18

壹、出國目的及緣由

配合二所八十九年經濟部軍民通用科技「機械業關鍵系統技術研究發展計畫」計畫中之「非連續塗佈」子項計畫需求，赴美國 CALEB 公司、n & k Technology 公司及 AEROTECH 公司等...三家公司，研討鋰電池、線性馬達、薄膜厚度量測技術並蒐集該三家公司最新之發展現況與資料，作為本所未來發展科專案之參考。

貳、公差心得

一、 高速化與高精確度是未來半導體製程設備的驅勢。半導體製程設備投資動輒數億甚至數百億美元，而電子零件的價格卻隨時間逐漸下跌，因此投資人已由以往僅要求高精確度的心態，逐漸轉變為高精確度為基本要求，生產速率才是考慮的重點，線性馬達的出現被認為是未來半導體製程速率提昇的重要突破，近年來已有部份半導體製程設備改用線性馬達以提高生產效率，線性馬達主要之特性為：

- 直接驅動、無背隙。
- 高加速度、大範圍操作速度。
- 提供高剛性、長行程。
- 經由迴授裝置，精度及重現性高，精度可達 $0.1\mu\text{m}$ 等級。
- 經過伺服控制，比導螺桿具有更高之剛性。
- 無磨擦、免維修。

因此如何應用線性馬達來開發製程設備，將成為未來的趨勢。

二、 和半導體有關的製程均和薄膜脫離不了關係，例如 IC 晶片的製造就是先在鈔晶片上鍍上 4-6 層，不同材質與成份之薄膜，再用蝕刻的方式將需要之元件製造出來，目前手提電腦使用之液晶螢幕，其製程原理亦相同，可見薄膜量測技術在半導體產業的重要性，因此如何選用功能強大之薄膜量測設備，對於半導體廠商非常重要，一部優異之薄膜量測設備所需具備之功能如下：

- 精確度高
- 操作容易
- 資料庫要充足
- 要能夠同時量測 3 層以上之薄膜
- 量測面積要大
- 量測速度快

三、 薄膜製程非常多樣化（例如浸沾塗佈法、噴塗法、滾筒塗佈法、旋轉塗佈法、擠出塗佈法、網板印刷法等...）應用也非常廣泛，不同的塗佈法所獲得之薄膜，膜厚精度範圍亦不同，各種製程亦各有其不同之應用領域。

研發人員選擇塗佈方式所必須考量之重點為：

- 產品之厚度
- 精度需求
- 生產環境需求(真空或低濕)
- 生產速率需求
- 塗佈原料之特性

如何選擇最經濟與快速的方式，製造出符合精度要求的產品是研發人員的責任。

四、參訪 CALEB 公司之所見與心得：

CALEB 公司是一鋰電池研究與發展公司，一般鋰電池是使用液態鋰離子溶液為原料製造鋰電池，由於鋰離子在一般環境下容易潮解，並釋放出有毒之氣體，因此必須將鋰離子密封在金屬外殼中，CALEB 公司使用固態鋰離子化合物為原料製造鋰電池，因此其製造程序與我們使用之方法類似，先以塗佈方式製造一片片固態鋰離子化合物片，再堆疊成鋰電池。

由 CALEB 公司所提供之電池性能測試資料（參考附件一）及和研發人員討論結果顯示，CALEB 公司所研發之鋰電池其性能比現在商品化之鋰電池性能更佳，電流密度更大是未來的明日之星。

然而實際參觀該公司之研發與試產實驗室，發現目前該公司所面臨之困擾為產品良率不高的問題，導致已完成研發，樣品測試性能也非常優異，卻遲遲無法量產上市之主要因素。

經與 CALEB 公司研發部經理討論，造成產品良率不高的主要原因為供電電流不穩定，容易造成鋰電池燒毀，分析原因可能是鋰離子化合物薄膜厚度不均勻，造成電

流容易往厚度較小、電阻值較低的區域集中，造成瞬間電流過大而將電池燒毀。

我們亦將目前所研發之薄膜塗佈設備規格，與 CALEB 公司研發部經理討論及交換意見，CALEB 公司研發部經理對我們所發展之塗佈設備非常感興趣，並希望完成後能夠優先試用，用於生產鋰電池。

五、參訪 n & k Technology 公司之所見與心得：

n & k Technology, Inc. 是專業生產量測鍍膜厚度儀器設備之公司，鍍膜厚度量測系利用不同成份與厚度之薄膜其反射係數、穿透係數與繞射角的差異，利用此差異即可量測不同薄膜之厚度。

n & k Technology, Inc. 研究此方面之技術多年，對目前市面上常用之塗佈材料已建立完整之資料庫，因此量測準確性非常高，本次公差至該公司參訪，該公司研發部經理先對膜厚度量測技術做一深入淺出之說明（幻燈片內容詳如附件二）。

現場工程師先將 1512RT 型號之膜厚度量測儀的操作程序做一簡單的介紹，然後由陳瑞宗及蕭俊誠實際操作，n & k Technology 公司在這套軟體果然下了不少功夫，大部份的操作簡單易學，一會兒功夫我們都會執行使用前校正及做簡單的量測工作，1512RT 型號之膜厚度量測儀具有大面積之吸盤（這個吸盤設計非常輕巧，和我們所研發之薄膜塗佈機上固定玻璃基板的吸盤類似，不過 n & k Technology 公司設計較為輕巧方便）可以量測 40*40cm 以上之工件，比較陳瑞宗及蕭俊誠對同一薄膜實際測試

結果，兩次測試結果非常接近，顯示該膜厚度量測儀重覆精度非常優異（測試結果詳如附件三）。

我們同時也參觀該公司之生產線，研發部經理為我們介紹不同應用範圍之其他型號之量測儀，其中最引人注意的是，n & k Technology 公司正在發展的線上膜厚檢驗系統，型號為 n & k Analyzer 3000（參考附件四），研發部經理私下表示，提高良品率是目前各半導體廠的首要目標，所以該機種雖然尚在研發階段就已經有好幾部訂單。

六、參訪 AEROTECH 公司之所見與心得：

速化高精確度是目前半導體製程的重要需求，如何在最短時間內開發出合乎性能要求的設備，零組件的選用相形下就顯得非常重要。

AEROTECH 公司是一典型之自動化設備生產工廠，我們向營業部經理說明我們希望了解線性馬達、伺服器及控制軟體等相關產品及規格，營業部經理立即安排不同的部門經理向我們說明。

線性馬達是我們此行的重點，線性馬達部門經理向我們介紹 AEROTECH 公司線性馬達規格（參考附件五），並依據我們目前的需求，幫我們搭配適當之機型，討論中我們也提及目前我們安裝所遭遇的卡機問題，線性馬達部門經理表示，安裝這種高精度的移動系統，須要利用高精度的雷射干涉儀及豐富的安裝經驗，否則卡機是常見的問題，建議我們採用該公司 ABL8000 Linear Air Bearing Stages（參考附件六），該系統出貨前已經在工廠調整好，可以節省調校的問題。

到達伺服器部門，部門經理已經在等我們，部門經理先對 AEROTECH 公司所生產的伺服器做一簡單的介紹，同

時帶領我們參觀生產工廠，途中聊天時談到該部門主要生產控制線路板，我們告訴他目前臺灣是線路板生產王國，委託臺灣生產一定可以節省一半已上的成本，之後我們又和部門經理討論介面問題，應該可以和目前使用的系統配合。

最後我們參觀控制軟體部門，AEROTECH 公司有自行發展之控制軟體也可以和一些常用之控制軟體聯結，由於我們目前已使用 LabVIEW 為控制軟體，不適合再使用其他軟體徒增介面問題，AEROTECH 公司之伺服器有提供 LabVIEW 軟體的驅動程式，已符合我們的需求。

AEROTECH 公司所發展之線性馬達、空氣軸承、伺服器及控制軟體，已經模組化所以使用該公司之零組件來建立生產系統非常方便，可以有效降低生產設備之研發時程。

參、效益分析

綜合此次參訪行程，可以看出半導體產業設備未來發展方向，近年來部份零組件均有模組化驅勢，且搭配電腦軟體的發展易學易用已是不可避免的驅勢，此次為經濟部科專案的訪廠行動中，所得到的效益有：

- 一、n & k Technology 公司發展之測試軟體操作簡單容易學習、測試設備精確度高準確性好、大面積之吸盤設計非常輕巧、了解客戶的需求發展線上檢驗系統協助半導體廠商提高良率；這些觀念都值得我們學習。
- 二、AEROTECH 公司所發展之線性馬達、空氣軸承、伺服器及控制軟體，已經模組化設計，所以使用該公司之零組件來設計與建立生產系統非常方便，而且可以有效降低研發時程；值得我們參考。
- 三、CALEB 公司所研發之鋰電池其性能比現在商品化之鋰電池性能更佳，電流密度更大是未來的明日之星。從參訪中我們亦體會到目前薄膜塗佈計畫，所開發之塗佈技術不僅可用於生產液晶螢幕，此種技術亦可用於生產鋰電池等...相關產品；這種結果對我們研發人員有正面之激勵作用。

肆、國外工作日程表

項次	日期	地點	交往接觸人士及機關 (外文名及譯名)				洽談內容紀要
			姓名	國籍	性別	地址	
1.	10/20	美國 洛杉磯	Thomas S. Lin Raffaele La Ferla	美國 美國	男 男	23935 Madison Street Torrance, CA 90505	·由 Raffaele 研發部經理介紹 CALEB 公司所研發之鋰電池特性。 ·參觀 CALEB 公司之研發實驗室。
2.	10/21-10/22	美國	行程				
3.	10/23	美國 聖何西	Tracy L. Scott John C. Lam	美國 美國	男 男	3150 De La Cruz Boulevard Santa Clara, California	·由 n&k 公司工程師 John 介紹膜厚量測基本原理。 ·業務經理 Tracy 先生帶領參觀研發與製造部門。
4.	10/24	美國	行程				
5.	10/25	美國 匹次堡	Albert P. Ciez Tom Markel	美國 美國	男 男	101 Zeta Drive, Pittsburgh, PA 15238-2897	·AEROTECH 公司線性馬達部門經理 Tom 先生為我們介紹及討論線性馬達規格。 ·系統整合部門經理 Albert 先生為我們介紹控制器及軟體架構。

伍、社交活動

一、在參訪聖荷西時，有機會和蕭俊誠先生的侄子

MICHAEL CHIU 餐敘，MICHAEL CHIU 先生在 CBM SYSTEMS INC 上班，CBM SYSTEMS INC 以生產工作站 (SUN) 等...高速電腦聞名，從訪談中我們也了解國外電腦發展的趨勢。

二、再洛杉磯停留期間，亦順路拜訪陳瑞宗先生的高中同學，兩人 20 多年未見面，竟在國外相聚，感覺非常興奮。

陸、建議事項

- 一、目前我們安裝塗佈機遭遇到卡機的問題，據了解，安裝這種高精度的移動系統，需要利用高精度的雷射干涉儀及具備豐富的安裝經驗，目前我們尚無這方面之能力與設備，建議直接應用現成調校完成之組件，以節省研發的時程。
- 二、為提高產品的良率，將膜厚度量測技術導入半導體生產製程中，已是未來半導體製程設備發展的趨勢；本研究計畫內許多結果也需要膜厚度量測技術來驗證，因此及早投入適當人力研究膜厚度量測技術，對後續本院在半導體製程設備之研發應該有非常大之助益。

附件

附件一：鋰電池性能測試資料。

附件二：膜厚度量測原理

附件三：1512RT 型號之膜厚度量測儀測試結果

附件四：Analyzer 3000 膜厚度量測儀

附件五：AEROTECH 公司線性馬達規格

附件六：ABL8000 附空氣軸承之移動平台規格

附件一：鋰電池性能測試資料。

Advancell™
Solid-State Lithium-Polymer
Rechargeable Battery
Performance and Key Technologies

CALEB TECHNOLOGY CORPORATION
23935 Madison Street, Torrance, Ca 90505 Tel: (310) 373 6888 Fax: (310) 373 8793 e-mail: calebys@aal.com

 **CALEB** TECHNOLOGY CORPORATION

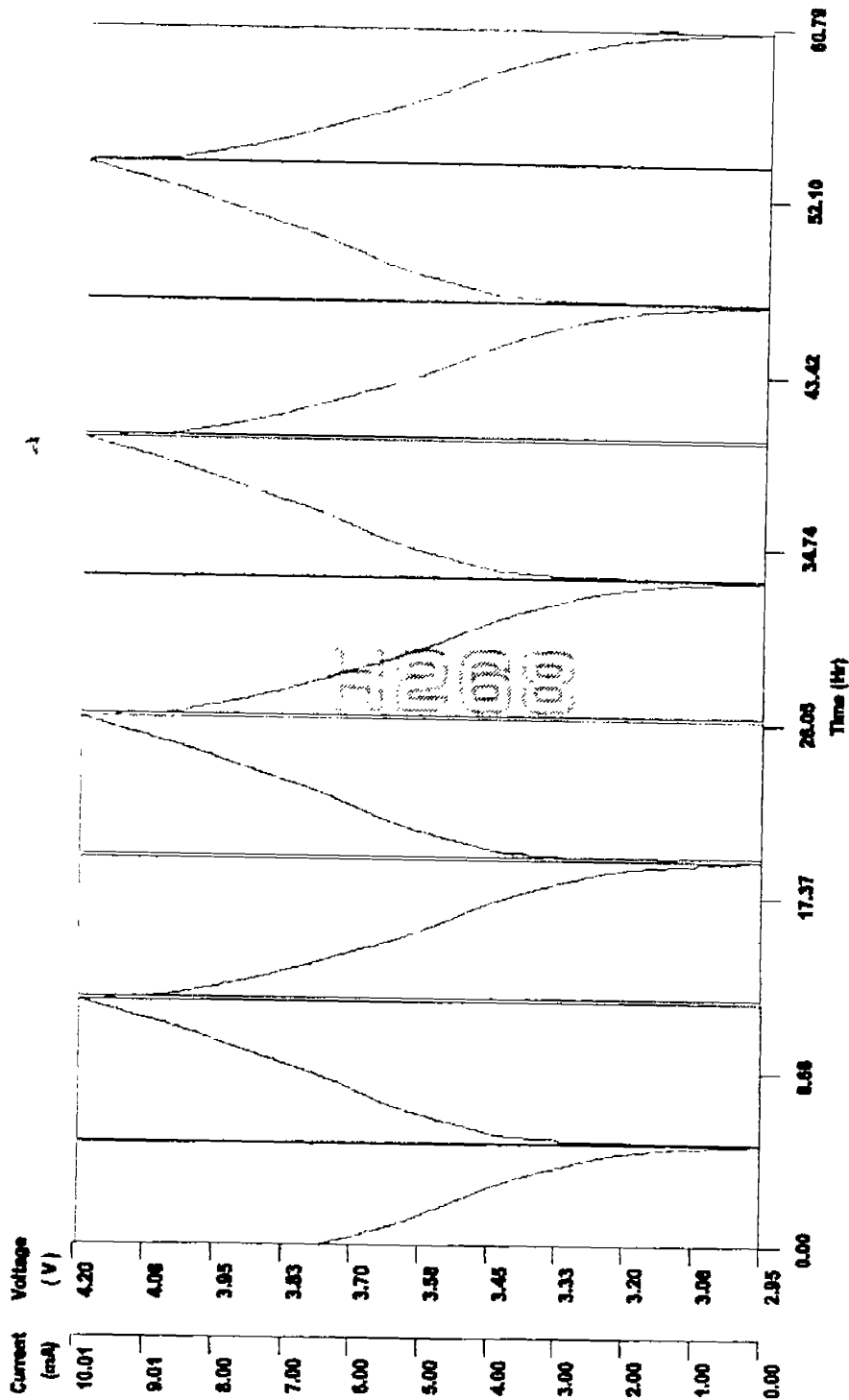
- Start-up technology development company established in early 1998
- Developed state-of-the-art solid lithium-polymer rechargeable battery
- Targeting \$17 billion world market



 **CALEB TECHNOLOGY Advance//™ System**

Anode	Graphite, and Carbon-TiO₂-Sn composite (up to 600 mAh/g reversible capacity)
Electrolyte	Biphasic composite polymer (3.6 mS/cm and Voltage stability window exciding 5 Volt)
Cathode	Metal Oxides: LiNi_{0.8}Co_{0.2}O₂
Current Collectors	Aluminum and Copper Mesh
Packaging	Laminated pouch materials

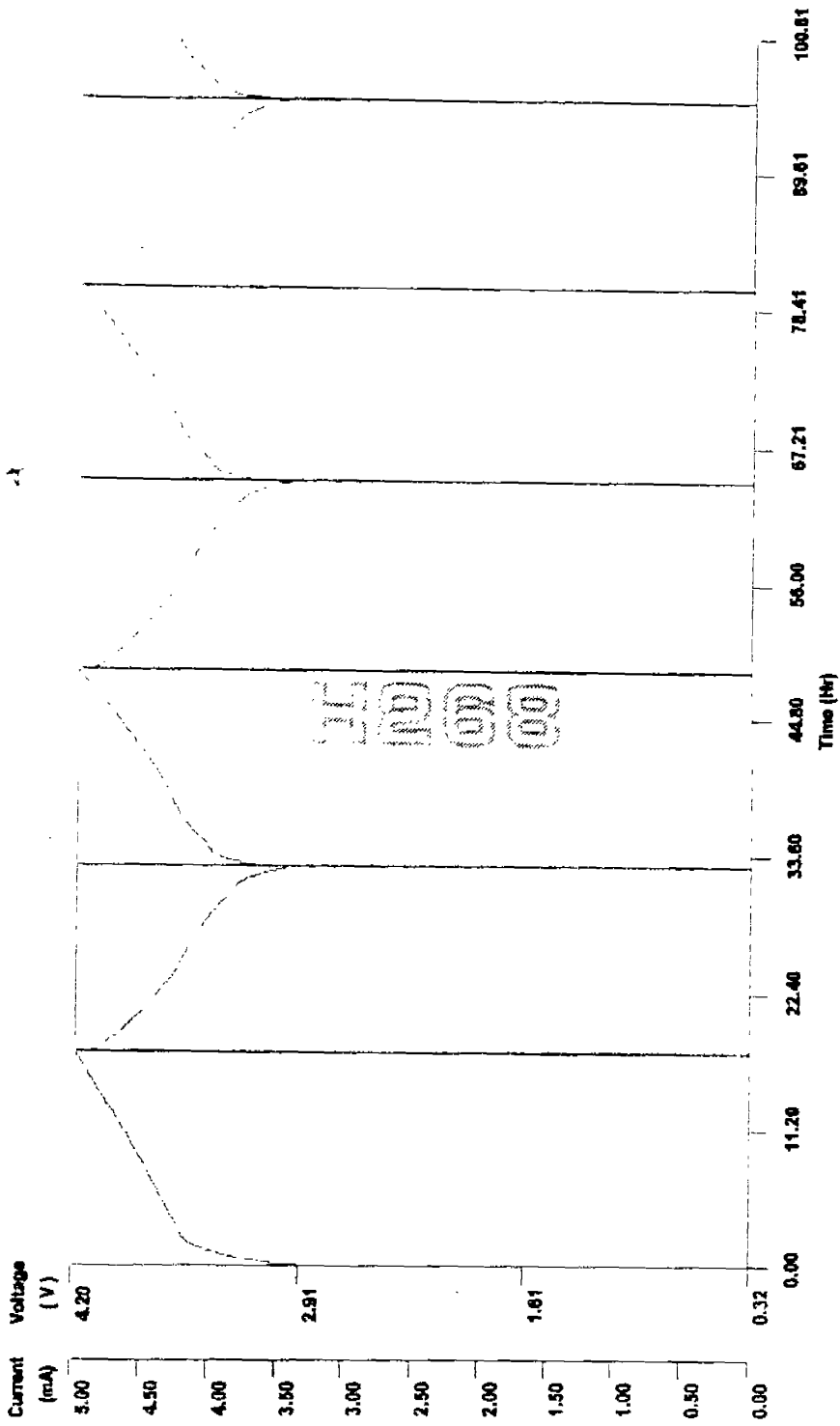
Cyclic Charge/Discharge at Constant Current of 0.2C



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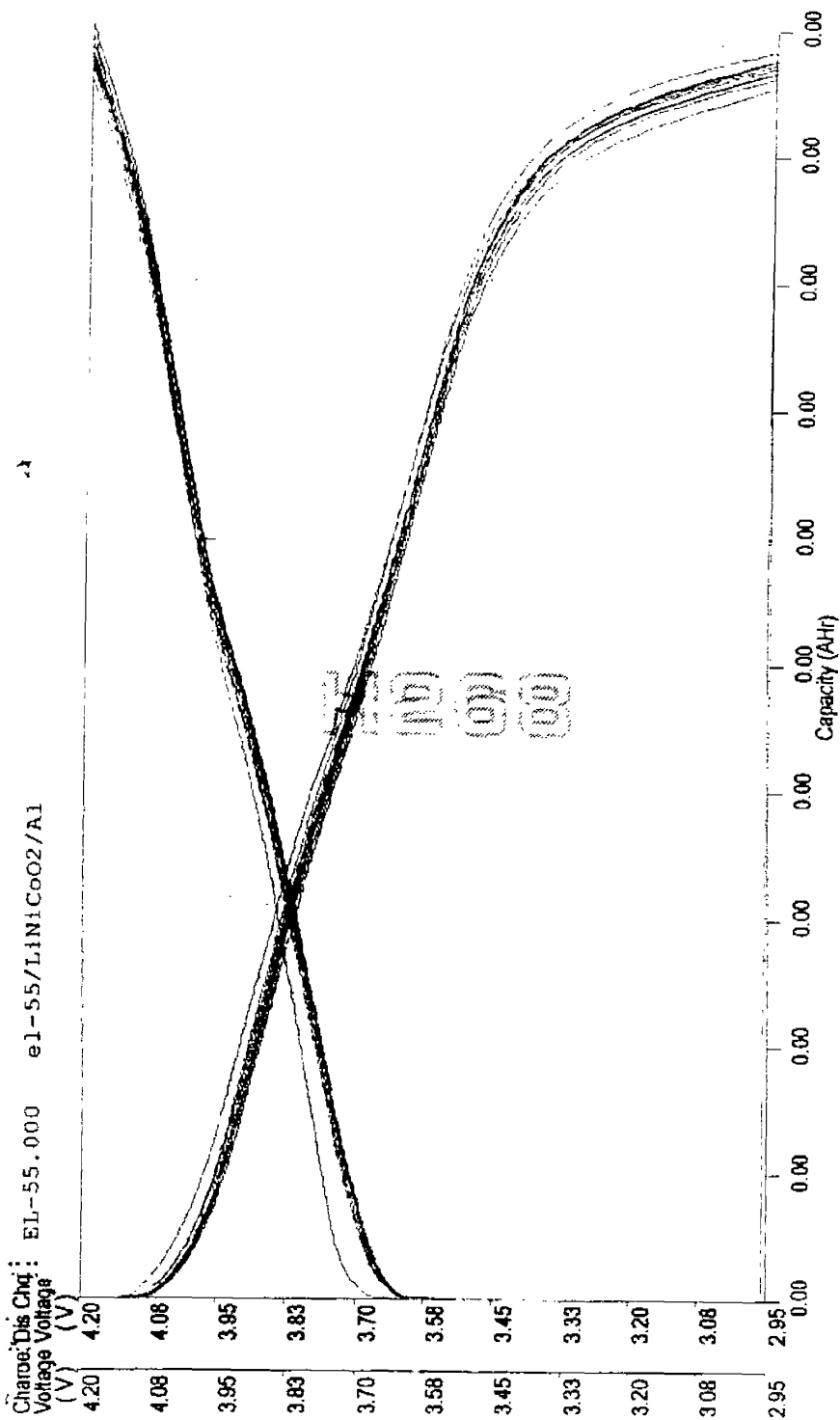
Cyclic Charge/Discharge at Constant Current of 0.1C



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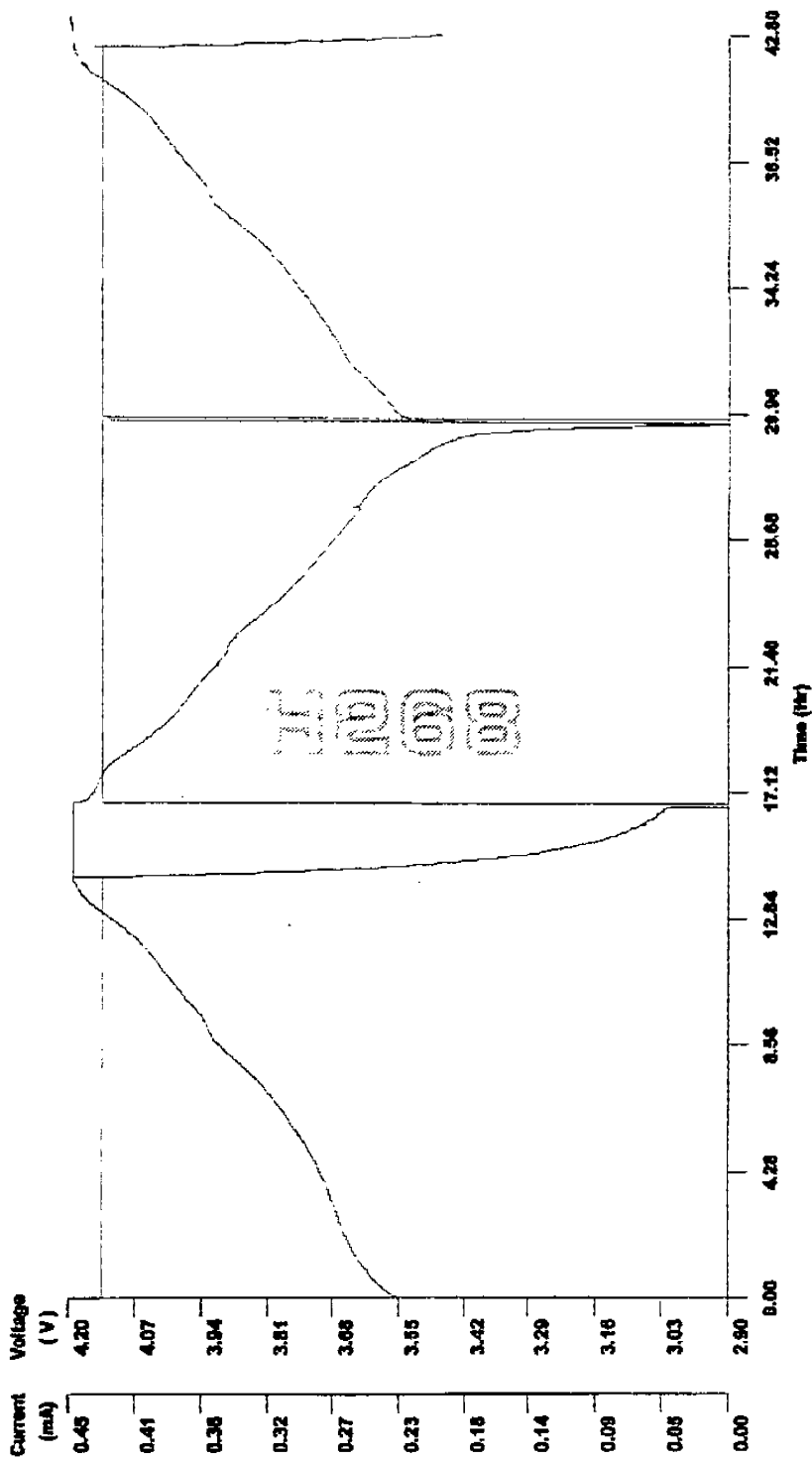
Cycling Behavior of *Advancell*TM at 25°C



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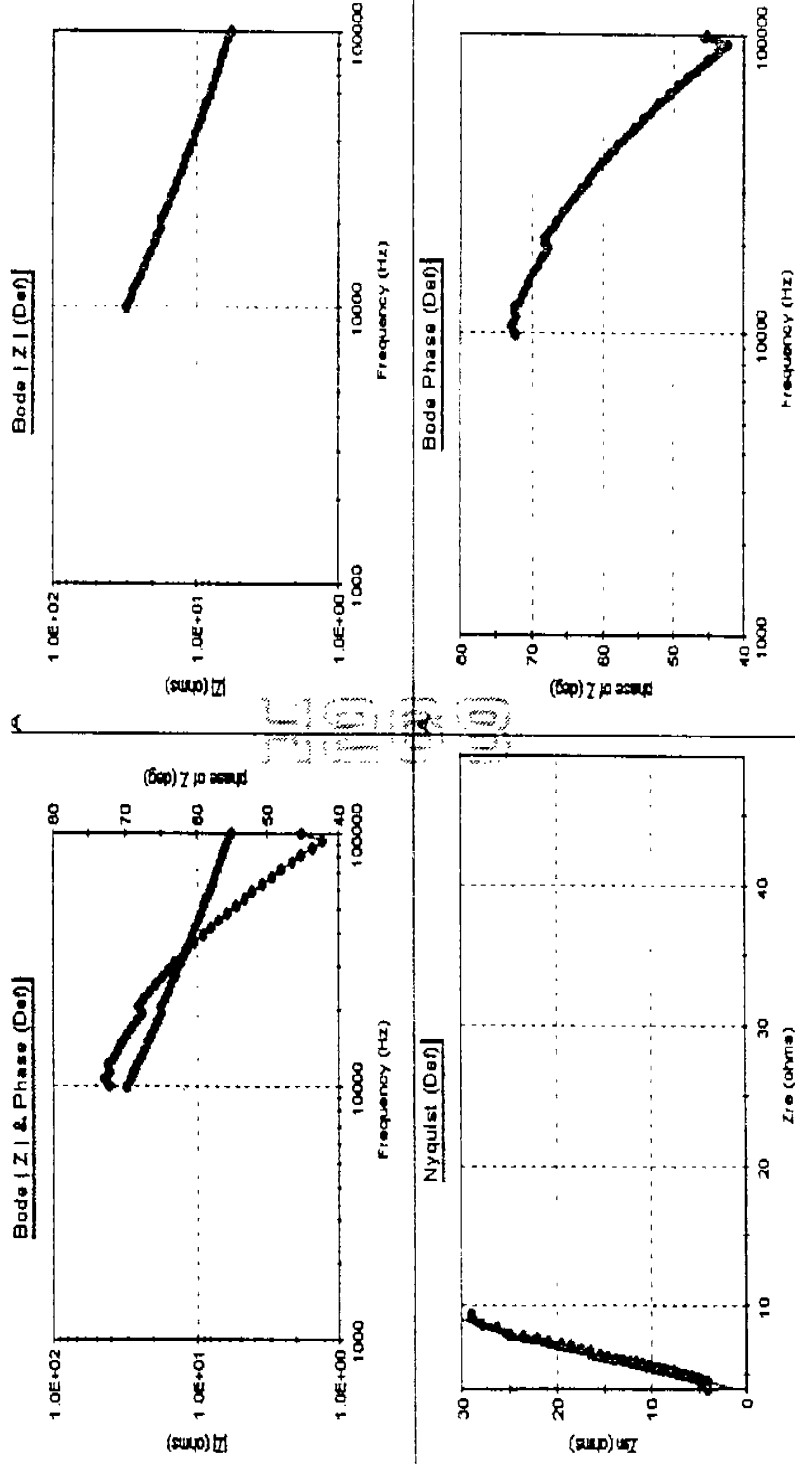
Charge/Discharge Characteristics of a Complete *Advancell*TM



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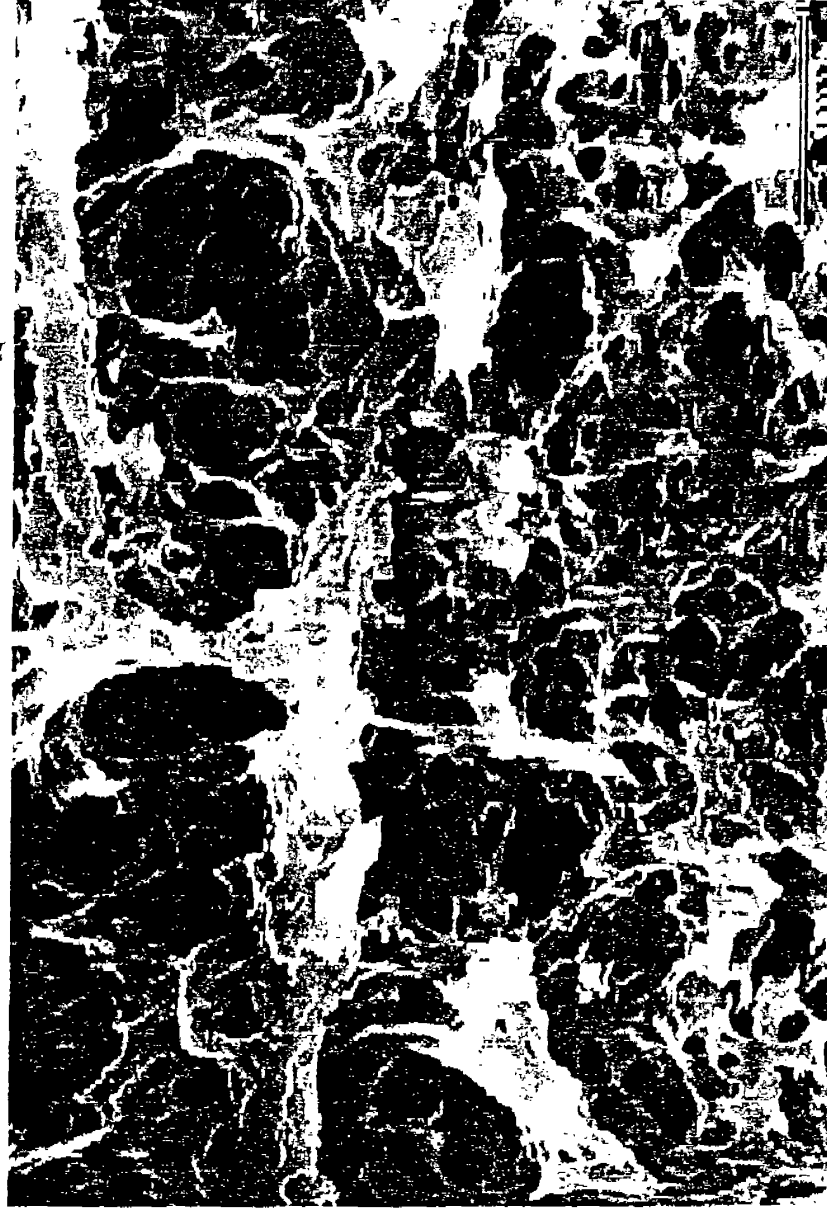
Typical Impedance Scan of CALEB's Proprietary Polymer Electrolyte System having 3.6 mS/cm Conductivity



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Polymer Electrolyte Biphasic Structure



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Advancell™ Credit Card Size Battery Specifications

2

Capacity	280 mAh at 0.2C
Nominal Voltage	3.8 Volt
Charge Method	Constant Current/Voltage
Cutoff Charge Voltage	4.2 Volt
Cutoff Discharge Voltage	2.9 Volt
Weight	~4.5 g
Thickness	~1.3 mm
Dimension: WxL	45x45 mm
Volumetric Energy Density	498 Wh/l
Gravimetric Energy Density	235 Wh/Kg



23935 Madison Street, Torrance, Ca 90505 Tel: (310) 373 6888 Fax: (310) 373 8793 e-mail: catebsys@aol.com

Advancell™ Safety Tests Summary

Test	Results
Short Circuit	In progress
Overcharge	In progress
Nail Penetration	Pass
Crush	Pass
Overdischarge	In progress
Heating	In progress



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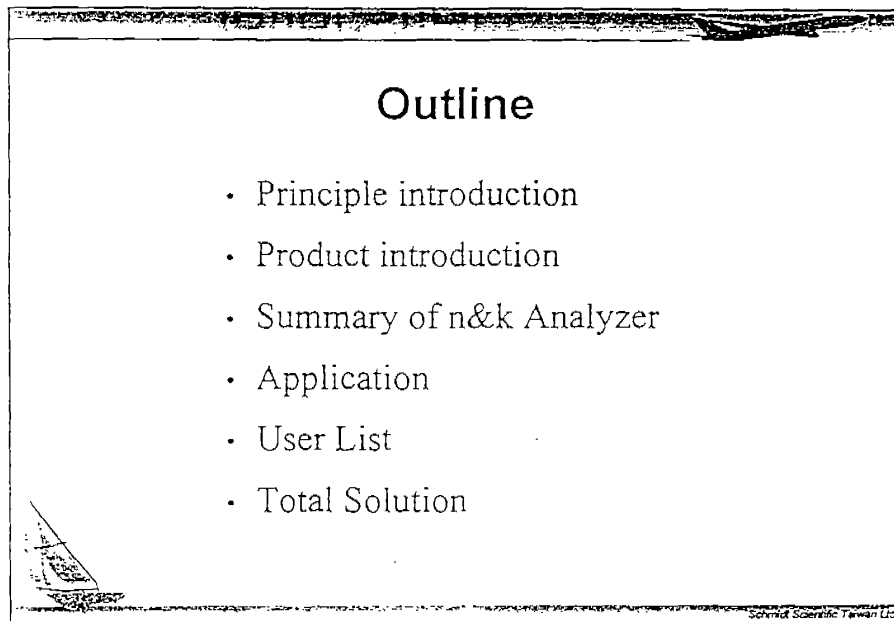
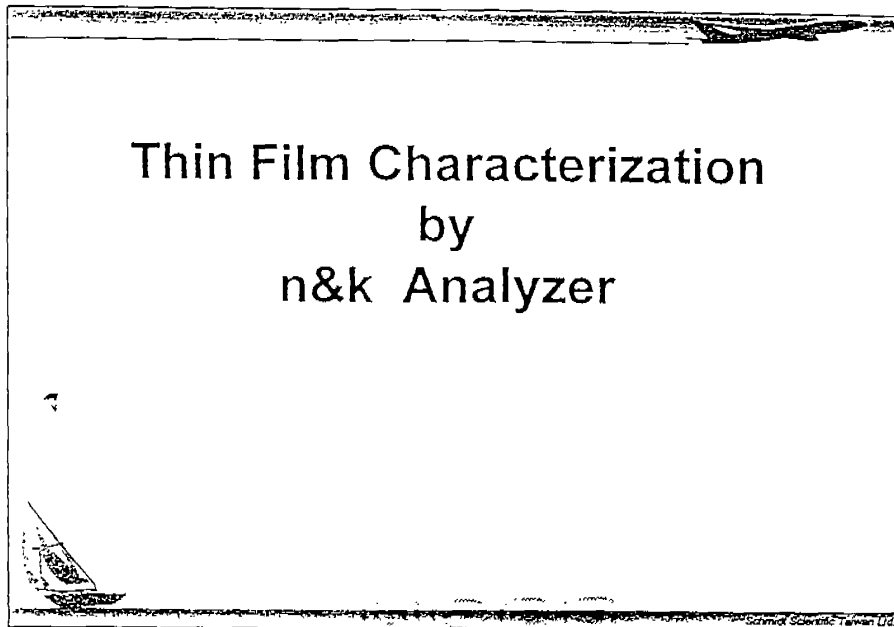
Product Development Initiative

- Anode material development with high specific capacity 600 mAh/g
- Hybrid polymer electrolyte system capable of retaining high conductivity (~3.6 mS/cm) after vacuum operations
- Low-cost materials optimization for all components
- High throughput fabrication processes



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附件二：膜厚度測原理



Optical Measurements

- Reflectance, R
- Transmittance, T
- Phase Shift, ϕ
are typically measured in order to optically characterize materials.
- The values of these quantities depend on the wavelength, λ , of light. Their values are different for different wavelength and incident angle
 - $R=R(\theta, \lambda)$
 - $T=T(\theta, \lambda)$
 - $\phi=\phi(\theta, \lambda)$

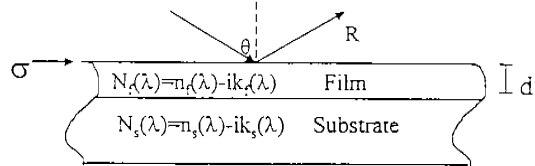
Schmid Scientific Taiwan Ltd

Using Only R, T, ϕ to Characterize Materials

- The measured values of $R(\lambda)$, $T(\lambda)$, and $\phi(\lambda)$ alone cannot be used to characterize thin films.
- They depend on a number of other quantities.
- These other quantities establish the actual characteristics of the material that is being measured.

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Thin Film on a Substrate



- $R(\lambda) = R[n_f(\lambda), k_f(\lambda), n_s(\lambda), k_s(\lambda), d, \sigma, \theta]$
- Reflectance, R , depends on:
 - n and k of film
 - n and k of substrate
 - film thickness, d
 - surface roughness, σ
 - angle of incidence, θ ($\approx 5^\circ$)

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The Challenge

Optical Characterization of Thin Films

Separate out the primary quantities

- n and k of each film
 - E_g of each film
 - n and k of the substrate
 - film thickness
 - interface & surface roughness
- from measured optical quantities (R, T, ϕ).

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Accurate Thin Film Characterization

Valid Model for Analysis

Integrity of Raw Data



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Valid Model for Analysis

A valid physical model should be used to analyze the measured raw data

1. Kramers-Kronig relationship for $n(\lambda)$ and $k(\lambda)$?
2. Number of parameters involved in using the model?
3. How well does model apply to dielectric, semiconductor, and metal films?



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Dispersion Equation

Cauchy Model

$$n^2(\lambda) = n_0 + \frac{n_1}{\lambda^2} + \frac{n_2}{\lambda^4} + \dots$$

$$k^2(\lambda) = k_0 + \frac{k_1}{\lambda^2} + \frac{k_2}{\lambda^4} + \dots$$

- Too many parameters
- Don't satisfied K-K relation
- Mono-increasing function
- No perfect $k=0$

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Dispersion Equation

Harmonic Oscillator model

$$\varepsilon_1(\omega) = n^2 - k^2 = 1 + \sum_i \frac{\omega_{pi}^2 (\omega_{0i}^2 - \omega^2)}{(\omega_{0i}^2 - \omega^2)^2 + \gamma_i^2 \omega^2}$$

$$\varepsilon_2(\omega) = 2nk = \sum_i \frac{r_i \omega \omega_{pi}^2}{(\omega_{0i}^2 - \omega^2)^2 + \gamma_i^2 \omega^2}$$

- Too many parameters
- Mono-increasing function

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The Conventional Dispersion Formulas

- Too many parameters.
- Valid over a very limited range of wavelengths.
- Do not satisfy the Kramers-Kronig relations.



F-B Dispersion Equations

$$k(E) = \sum_{i=1}^g \frac{A_i (E - E_g)^2}{E^2 - B_i E + C_i}$$

$$n(E) = n(\infty) + \sum_{i=1}^g \frac{B_{0i} E + C_{0i}}{E^2 - B_i E + C_i}$$



Parameters in the F-B Equation

A: is proportional to position matrix element squared

C: is related to the life time of the excited state.

B: is related to the difference in energies between critical states in the conduction and valence bands.

E_g: is the energy band gap.



F-B Dispersion Equation

We have found that the extinction coefficient, k ,
i.e., the imaginary part of the complex index of refraction,

$$N = n - ik$$

is related to photon energy, E , through the following relation:

$$k(E) = \sum_{i=1}^a \frac{A_i (E - E_g)^2}{E^2 - B_i E + C_i}$$

$$(E = hc / \lambda)$$



F-B Dispersion Equation

- According to the Kramers-Kronig dispersion relation:

$$n(E) - n(\infty) = \frac{1}{\pi} p.v. \int_{-\infty}^{\infty} \frac{k(E') - k(\infty)}{E' - E} dE'$$

Inserting the F-B equation for $k(E)$ into the Kramers-Kronig integral, we derived

$$n(E) = n(\infty) + \sum_{i=1}^n \frac{B_{0i} E + C_{0i}}{E^2 - B_i E + C_i}$$

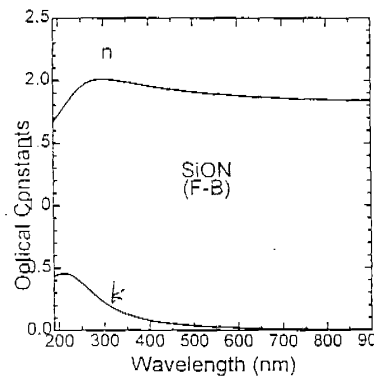
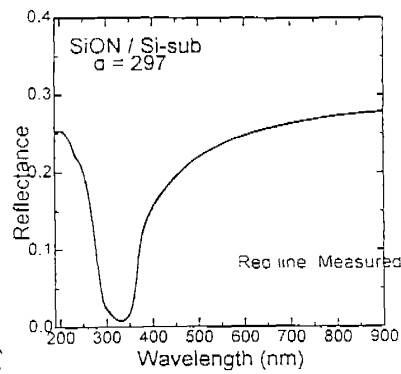
$$B_0 = \frac{1}{Q} (-\frac{B}{2} + E_0 B - E_0^2 + C)$$

$$C_0 = \frac{1}{Q} [(E_0^2 + C) \frac{B}{2} - 2E_0 C]$$

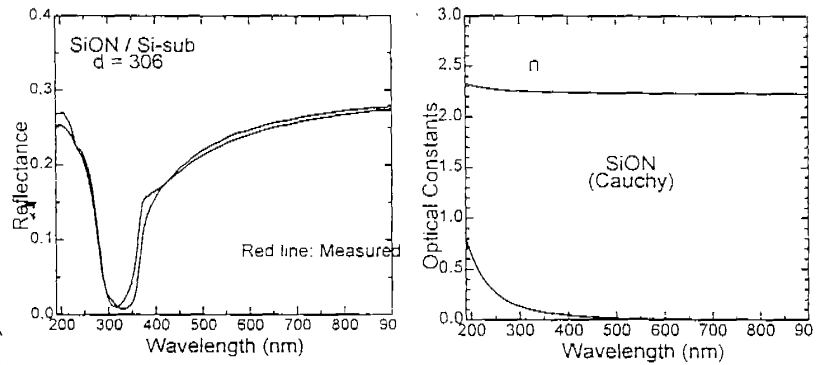
$$Q = -4C - B^2$$



Silicon-Rich SiON film on Si substrate

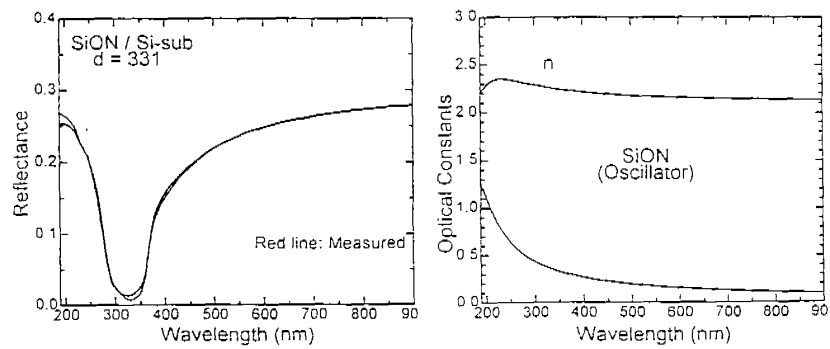


Silicon-Rich SiON film on Si substrate



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Silicon-Rich SiON film on Si substrate



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Integrity of Raw Data

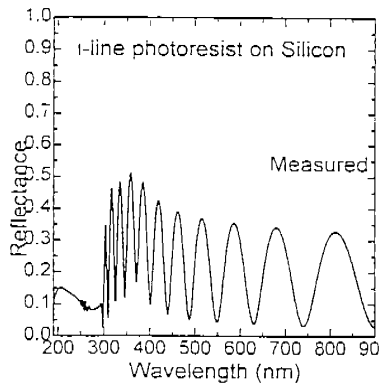
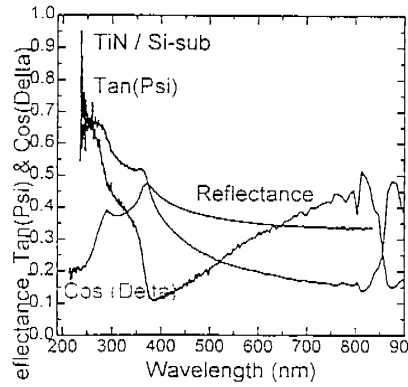
1. Wavelength Range

The measured raw data should cover the entire deep UV to near IR wavelength range (190 to 1000 nm)

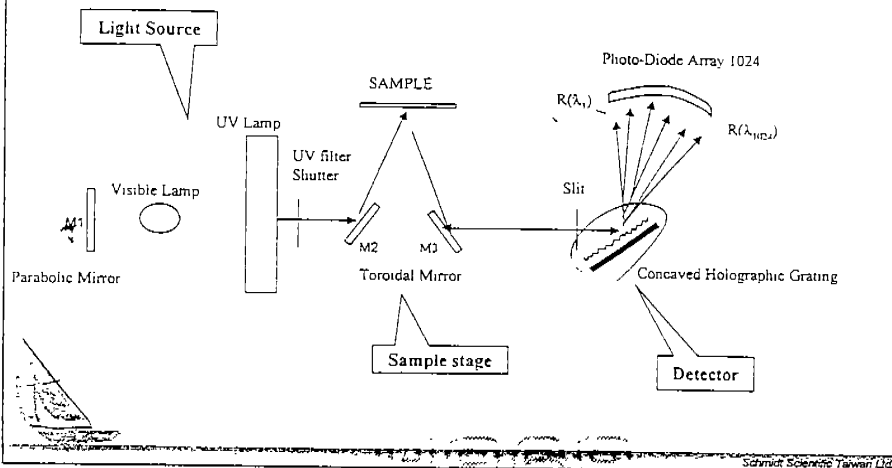
2. Signal to Noise

The measured raw data should have a good signal to noise ratio over the entire 190 to 1000 nm wavelength range

Integrity of Raw Data



Face Down Optical Setup



The n&k Method

Measure Reflectance or Transmittance Spectrum $R(\lambda), T(\lambda)$
Wavelength, λ , covers UV-Vis-NIR range (from 190nm to 1000nm)

Simultaneously Determine

Thickness
 $n(\lambda)$ and $k(\lambda)$ spectra (190nm to 1100nm)
 E_g (energy band gap)
of the film

Correlate n and k Spectra to Materials Properties, such as:

Composition
Resistivity
Crystallinity

Example: SiN_x Films

Depending on processing conditions, such as gas flow ratio of SiH₄ and NH₃, as well as plasma power, varying amounts of Si and N can be incorporated into silicon nitride (SiN_x) films.

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Optimizing SiN_x Films

By properly adjusting the amount of Si, N, thickness of a SiN_x film, desired electrical and optical properties can be obtained:

- Overcoat
- ARC

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Example: SiN_x on Si

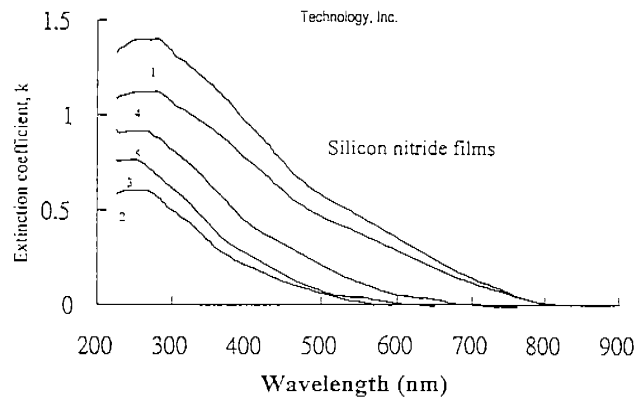
- We were given five Si-rich silicon nitride samples, deposited on Si.
- We determined, for each sample:
 - Thickness
 - n&k spectra (190nm to 1000nm)
 - E_g

ID	Thickness(A)	E _g (eV)
#1	373	2.00
#2	384	2.32
#3	305	2.30
#4	987	2.09
#5	1063	2.17

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n&k

Technology, Inc.



Schmidt Scientific Taiwan, Ltd.

c:\EES\data\n&kw.ppt 22
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Correlation of n&k Spectra to other Characteristics of SiN_x

1. Composition (Si-to-N ratio):

The larger the area under the k versus λ curve, the higher the Si-to-N ratio in the SiN_x film.

2. Resistivity:

The larger the E_g, the higher the electrical resistivity of the SiN_x film.

Schmitt Scientific Taiwan Ltd.

LPCVD Method: Amorphous to Crystalline Phase Transition

<u>Temperature T(°C)</u>	<u>Film Microstructure (Crystallinity)</u>
T < 550	Amorphous
550 < T < 575	Amorphous and polycrystalline phase coexist:(Amorphous dominates)
575 < T < 595	Amorphous and polycrystalline phases coexist:(polycrystalline dominates)
T > 595	Polycrystalline

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Critical Characteristics of as-Deposited Silicon Films

Initial as-deposited	Final Poly-Si (after oxidation)
Poly-Si:	<ul style="list-style-type: none"> • Smooth • Large grains • Dense
a-Si:	<ul style="list-style-type: none"> • Smoother • Larger grains • Denser
a-Si + Poly-Si:	<ul style="list-style-type: none"> • Rough • Small grain • Porous



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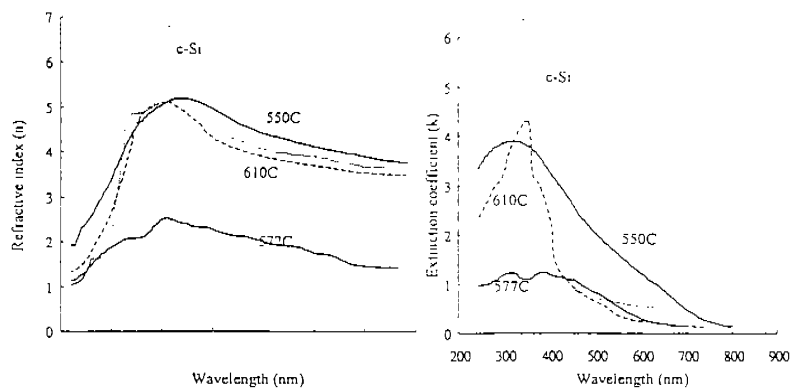


Figure 1. The n and k spectra from silicon films deposited below (550C), near (577C), and above (610C) the critical temperature, TC. The spectra of single crystal silicon are included for comparison.



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Correlation of n&k Spectra to Crystallinity of Silicon Films

Crystallinity (microstructure)

<u>Phase</u>	<u>shape of n&k spectra</u>
a-Si	One broad peak (Max.)
Poly-Si	One primary peak, plus other peaks and shoulders
a-Si/Poly-Si (mixed phase)	several peaks and shoulders, n&k are suppressed.

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Specifications of n&k Analyzer

Simultaneously determine the followings :

- $n(\lambda)$ λ from 190 to 1000nm, 1nm intervals
- $k(\lambda)$ λ from 190 to 1000nm, 1nm intervals
- $R(\lambda)$ λ from 190 to 1000nm, 1nm intervals
- $T(\lambda)$ λ from 190 to 1000nm, 1nm intervals
- Eg (Energy bandgap) for semiconductor & dielectric film
- Thickness:

Semiconductor films	10 A up to 10 μ
Dielectric films	20 A up to 10 μ
polymers (photoresist, etc.)	20 A up to 10 μ
Metal films	5 A up to 400 A

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Specifications of n&k Analyzer

Correlated to specific material characteristics

- a. Hydrogen content of a-C:H
- b. Nitrogen content of CN_x
- c. Degree of crystallinity of silicon films
- d. Silicon to Nitrogen ratio of SiN_x
- e. Resistivity & Oxygen flow of ITO
- f. Optical Density

Total Acquisition and analysis Time:

Typically 6 seconds for acquisition and analysis over the entire 190nm to 1000nm spectral range, per point.

Accuracy:

The accuracy of thickness, $n(\lambda)$, $k(\lambda)$, $R(\lambda)$, and E_g , are well within the accuracy of AFM, TEM, Ellipsometry, XRF, and Profilometry.

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n&k Analyzer

1. Can do things other instruments can't do:

- a. Simultaneously determine n,k,t from a single measurement.
- b. Characterize the multilayer structure upto 7 layers.
- c. Derive material properties from the measurement
- d. Determine n,k in the deep UV(190 to 300nm) spectrum,
In fact, the spectrum covered by n&k is from 190 to 1000nm
- e. Characterize films deposited on texture(rough) substrate
- f. Characterize films deposited on transparent substrate
- g. Characterize films that are absorptive
- h. Satisfy the Kramers-Kronig dispersion equation
- i. Take the surface & interface roughness into account
- j. Good signal-noise ratio in DUV region

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n&k Analyzer

2. Does it better, faster:

- a. Better---More accurate and comprehensive theory because of the F-B dispersion equation
- b. Faster---Data acquisition and analysis in Seconds
- c. Convinent--No "Dead Zone", No "Multiple Answer"
No "Assumption", No "Initial Guess"

3. Easy to use and Maintain:

- a. Simple Bench-top instrument
- b. Does not require sophisticated set-up, sample preparation calibration.
- c. Easy to maintain

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n&k Analyzer

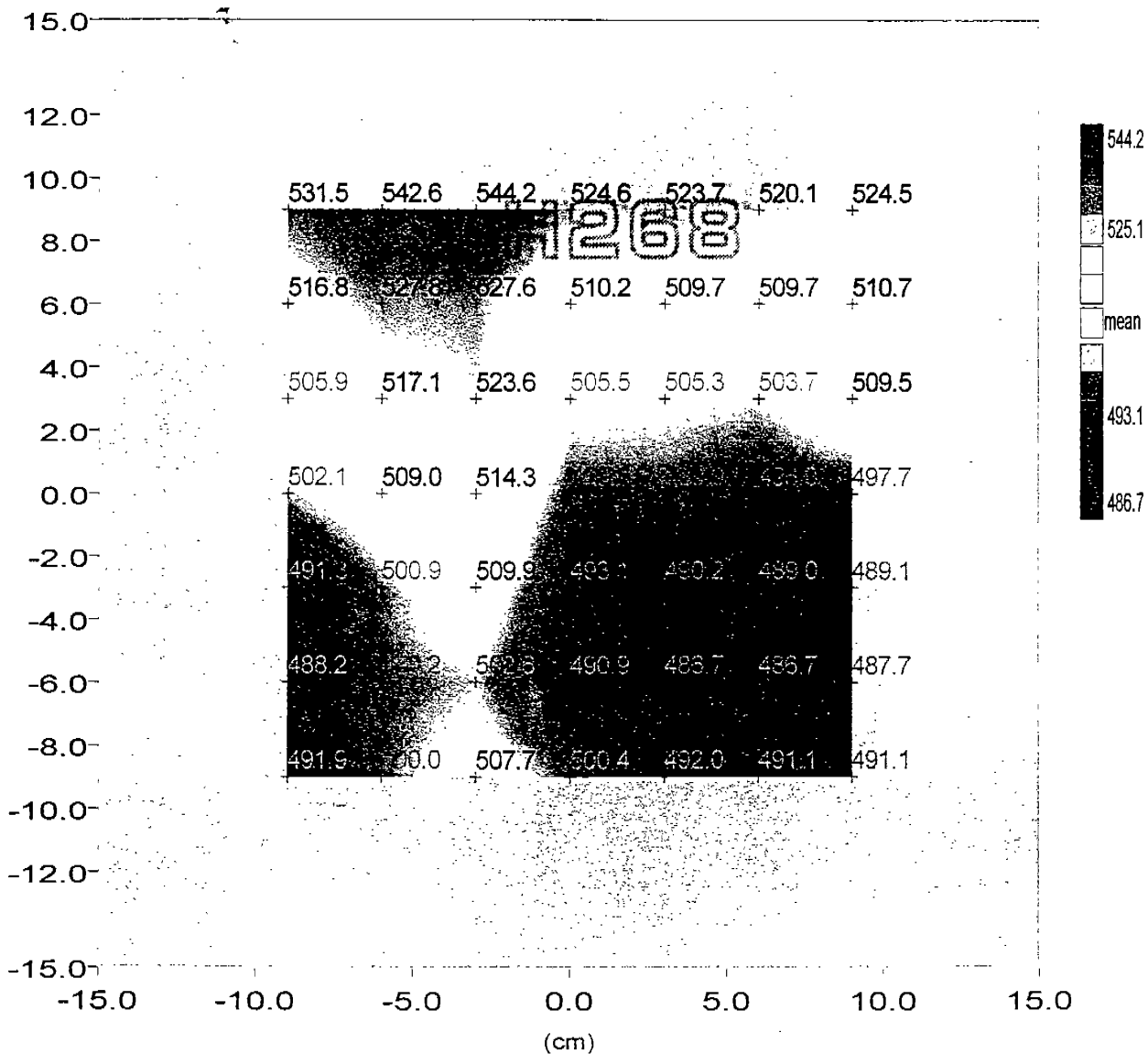
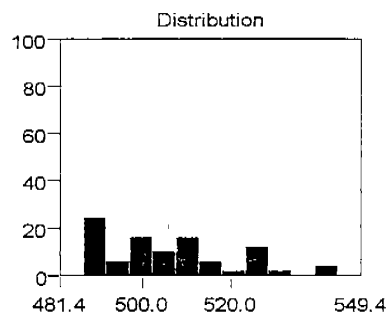
4. On-going support:

- a. Application support is provided to create customized measurement solution
- b. n&k provide an ever-increasing library of films for customer

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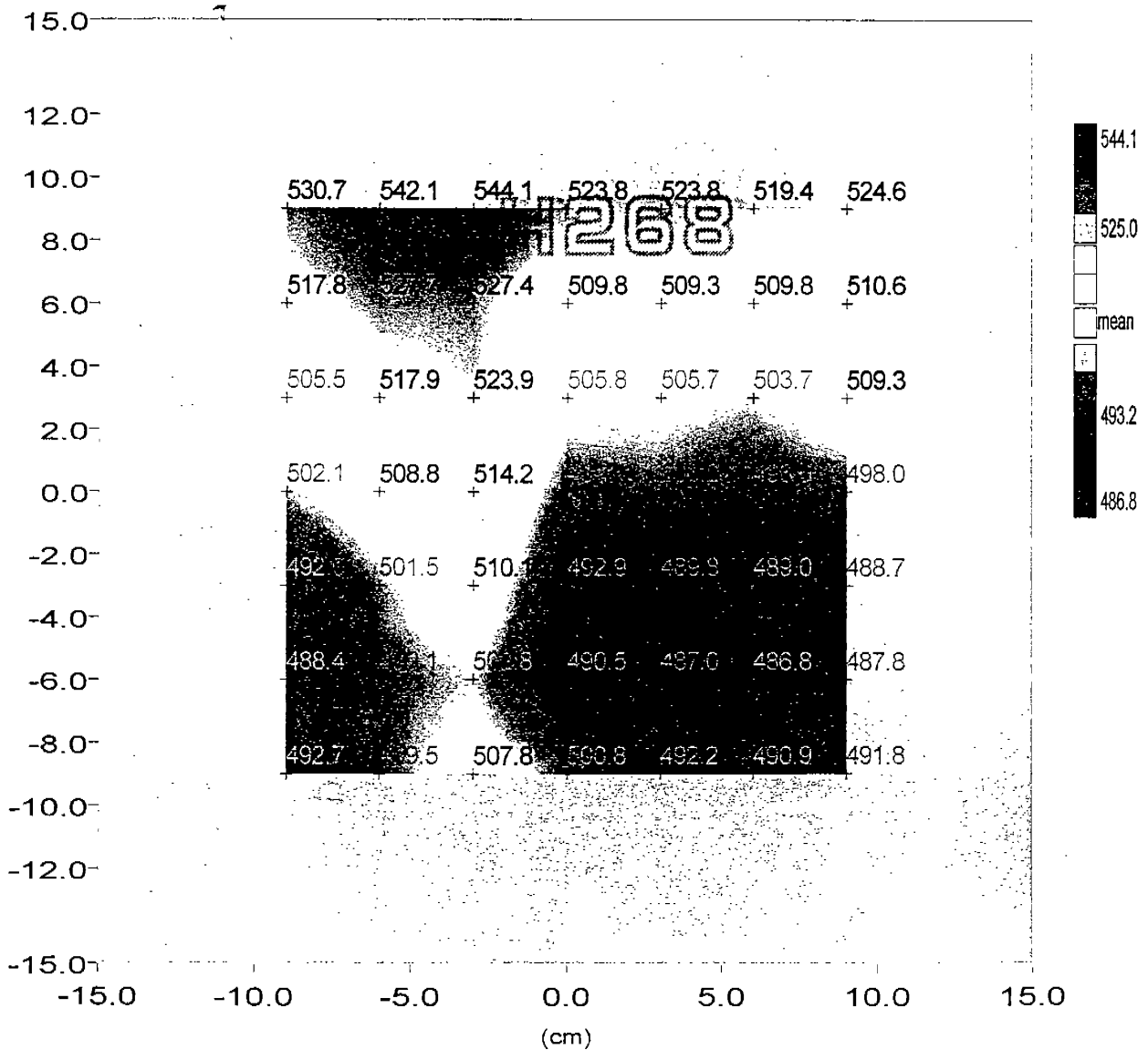
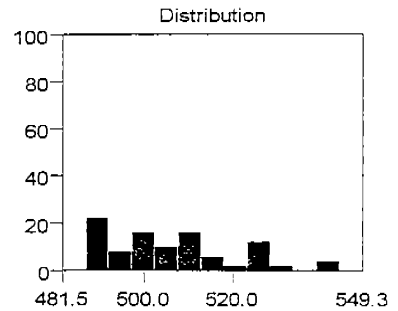
附件三：1512RT 型號之膜厚度量測儀測試結果 3T

Time & Date: 13:52:22 , 10-23-2000
 Result : Thickness for 1st layer/ITO (A)
 Numbers = : Absolute Results
 Lot Id : Lucent
 Sample Id : Z0036-48
 Operator : Huy
 Comments : non scribe side (rep)
 Statistics : Mean Value = 506.0 Std. Dev. = 14.72
 Max. Value = 544.2 Min. Value = 486.7
 Data Dir : c:\nkd\result\



Report from n&k Analyzer 1512RT

Time & Date: 14:02:21 , 10-23-2000
 Result : Thickness for 1st layer/ITO (A)
 Numbers = : Absolute Results
 Lot Id : Lucent
 Sample Id : Z0036-48
 Operator : Huy
 Comments : non scribe side (rep)
 Statistics : Mean Value = 506.0 Std. Dev. = 14.62
 Max. Value = 544.1 Min. Value = 486.8
 Data Dir : c:\nkd\result\



附件四：Analyzer 3000 膜厚度量測儀

n&k Analyzer 3000

Product Overview and Specifications

Fully Automated Thin Film Characterization System
for Patterned Wafers
For Features as Small as 10 μm
(2 μm in Certain Cases)

3000

MICRO-SPOT, UV CAPABILITIES, PATTERN RECOGNITION,
AUTOMATIC WAFER HANDLING, COMPUTERIZED MAPPING

UNPARALLELED accuracy and versatility

ADVANCED METROLOGY MAKES CHARACTERIZING MULTI-LAYER FILM
STACKS FAST AND EASY

The n&k Analyzer 3000 simultaneously and unambiguously determines:

- thickness
- spectra of optical constants (n and k) and reflectance (R)
from 190 to 1000 nm
- interface roughness
- energy band gap
- composition (e.g. %Ge in SiGe_x ; %N, %H, %O in
 $\text{SiO}_x\text{N}_x\text{H}_x$; %N in TiN_x or %H in CH_x ; %N in CN_x)
- microstructure (e.g. degree of crystallinity of poly-Si
or GST)
- resistivity (e.g. Indium Tin Oxide)

UNIQUE analytical features

Z-FILM ANALYSIS > Without any prior knowledge of the thickness or the optical constants of a film, whether amorphous or crystalline, the user can determine its thickness and n and k spectra (190 to 1000 nm). With the Z-film utility the user is able to tackle the analysis of materials that have never before been characterized.

KEY QUALITIES of the n&k Analyzer 3000

REMARKABLE OPTICAL DESIGN PROVIDES ACCURATE CHARACTERIZATION OF FILMS DEPOSITED ON PATTERNED SUBSTRATES

By combining an all-reflective optical design for a micro-spot, and field proven patterned recognition and robotics, the n&k Analyzer 3000 can readily characterize the complex film structures of semiconductor and GMR recording head wafers.

FAST AND EASY ANALYSIS IDEAL FOR MULTI-LAYERED STRUCTURES

The n&k Analyzer 3000 uses an intuitive graphical user interface based on Windows* NT or Windows 98 operating systems and takes just seconds to completely characterize even multi-layered structures. Eliminates the trial and error process typically encountered with other metrology tools. No need for initial guesses for film thickness, nor for any assumptions about the n and k values of the film.

FIELD-REPLACEABLE MOVING COMPONENTS AND MODULAR SET-UP FOR CONTINUED OPERATION DURING SERVICE

EXCELLENT SIGNAL TO NOISE RATIO OF RAW DATA THROUGHOUT ENTIRE 190 TO 1000 nm WAVELENGTH RANGE

With the n&k 3000's special patented optics, the complete spectral range from 190 to 1000 can now be measured using a micro-spot. And the signal to noise ratio is outstanding over the entire wavelength range! In order to accurately characterize very thin films, for example, TiN_x , SiO_xN_x , OPO, ONO, Cu, etc., it is critical to be able to measure the entire deep UV to NIR spectral range with a high signal to noise ratio

- | | |
|------------------|---------------------------------------|
| Characterizes | • semiconductors |
| Various Types of | • dielectrics |
| Films including: | • polymers (photoresist, resin, etc.) |
| | • metal films |

ULTRA-THIN FILM ANALYSIS > There is added capability for very accurate characterization of ultra thin films (<30 Å).

SIMULATION SOFTWARE > With the simulation software the user can determine the effect of variations in film parameters (like n , k , and thickness) on the reflectance, transmittance, and absorbance spectra, or can model these spectra for buried layers in a given structure. Also, absorbance, transmittance, etc., can be calculated at any desired wavelength. Can provide simulations of swing curves and standing wave forms.

THICKNESS
MEASUREMENT
RANGE

*For metal films >400 Å
thick, only the n and k
spectra of the films are
determined.

Semiconductor films
2 Å up to 10 μm or more

Dielectric films
2 Å up to 10 μm or more

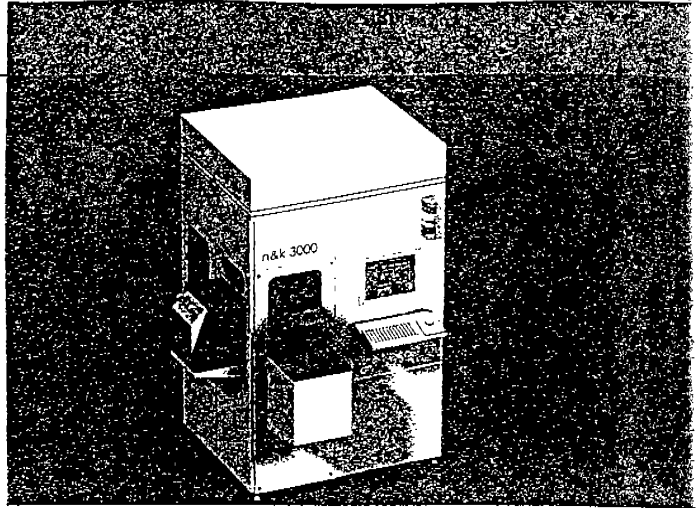
Polymers (photoresist, etc.)
2 Å up to 10 μm or more

Metal films*
2 Å up to 400 Å

the true measure... **n&k**

n&k Analyzer 3000

Fully Automated Thin Film Characterization System
for Patterned Wafers
For Features as Small as 10 μm
(2 μm in Certain Cases)



METHOD of analysis

The model used in the n&k Analyzer 3000 to analyze the raw data is based on the Forouhi-Bloomer Model for n and k . These equations are derived from the quantum theory of the absorption of light and are consistent with the Kramers-Kronig dispersion relationship for n and k . This model is quite general and applies to thin layers of semiconductors, dielectrics, dyes, polymers, "color filters", as well as metal films. Other tools rely on such models as the harmonic oscillator, Cauchy, Sellmeier, and Tauc equations for n and k . These equations are valid over a very limited range of wavelengths and are difficult to apply to films (single or multi layered) comprising "high tech" devices. The Cauchy, Sellmeier, and Tauc models do not satisfy the Kramers-Kronig relationship for n and k .

PHYSICAL CHARACTERISTICS

Dimensions WxDxH in mm	17" (431.8 mm)
Weight Unpacked	220 lbs
Facility Requirements	Requires clean room environment

TYPICAL PERFORMANCE

Test Material: SiO ₂ N ₂ on 6" Si Wafer				
	Thickness (Å)	n @ 365 nm	k @ 365 nm	R @ 365 nm
Mean	253.4	2.140	0.234	27.2%
Precision	0.2	0.001	0.001	<0.1% of R
Repeatability	0.4	0.003	0.002	<0.2% of R
Reproducibility	0.5	0.006	0.003	<0.3% of R

MEASUREMENTS ENABLED

Films deposited directly on smooth or rough substrates
Substrates can be measured

- Si₃N₄
- SiO₂
- TiN_x
- Si₃N₄/SiO₂
- SiO₂/Si₃N₄
- SiO₂/TiN_x
- SiO₂/Si₃N₄/SiO₂
- SiO₂/TiN_x/SiO₂
- SiO₂/TiN_x/Si₃N₄
- SiO₂/TiN_x/SiO₂/Si₃N₄
- SiO₂/TiN_x/SiO₂/Si₃N₄/SiO₂
- SiO₂/TiN_x/SiO₂/Si₃N₄/SiO₂/Si₃N₄
- SiO₂/TiN_x/SiO₂/Si₃N₄/SiO₂/Si₃N₄/SiO₂
- SiO₂/TiN_x/SiO₂/Si₃N₄/SiO₂/Si₃N₄/SiO₂/Si₃N₄
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- SiO₂/TiN_x/SiO₂/Si₃N₄/SiO₂/Si₃N₄/SiO₂/Si₃N₄/SiO₂/Si₃N₄/SiO₂
- SiO₂/TiN_x/SiO₂/Si₃N₄/SiO₂/Si₃N₄/SiO₂/Si₃N₄/SiO₂/Si₃N₄/SiO₂/Si₃N₄

ROBOTICS, FLAT/NOTCH FINDER, PATTERN RECOGNITION COMPONENT

Optional integrated SMIF provides mini-environment with 200 or 300 mm SMIF indexer

Robotics	
Wafer Throughput	Depends on number of points mapped: Example: 80 wafers/hour for 5 point map
Wafer Diameter	6" (150 mm) and 8" (200 mm) 12" (300 mm) option available
Vacuum Requirements	25 in Hg
Flat/Notch Finder	
Alignment Accuracy	0.04° for flats, ± 0.002° for x-y alignment
Pattern Recognition Module	
Based on field proven technology from Cognex Corporation	

DATA PROCESSING

- Computer: Pentium PC or higher
- Monitor: 15" Flat Panel Display
- Printer: Color Deskjet



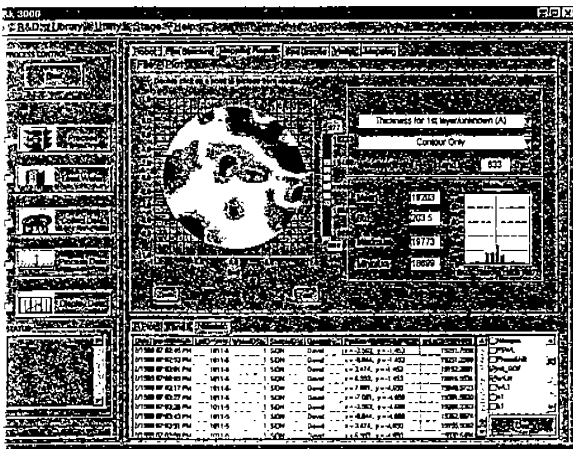
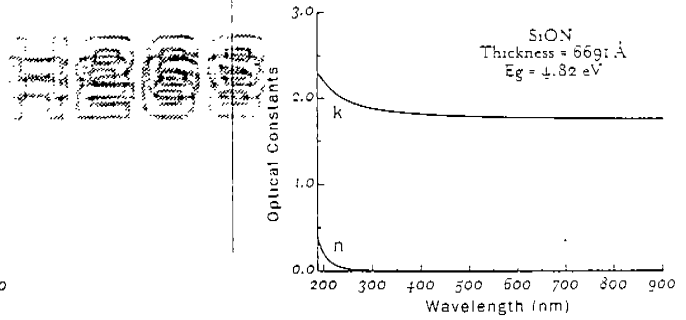
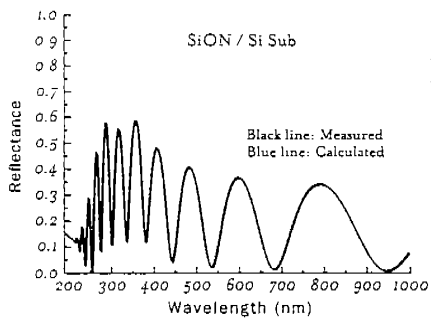
3150 De La Cruz Boulevard, Santa Clara, California 95051
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email: sales@nandk.com, support@nandk.com
www.nandk.com

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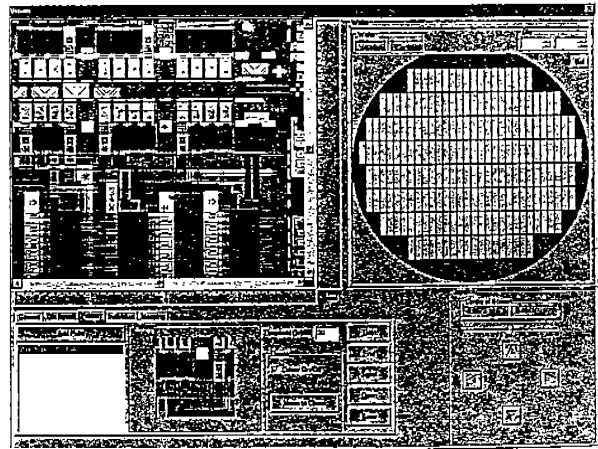
3000

STAGE

Type	Computerized X-Y Stage for wafers, plates or membranes
Maximum Travel of Stage	X: 200 mm (300 mm x-y travel available) Y: 200 mm
Maximum Speed of Stage	X: 100 mm/s Y: 100 mm/s
Mapping Patterns of Stage	User specified or preset patterns in both polar and rectangular coordinate systems
Spot Placement	1 μ m



Production screen of the n&k Analyzer 3000

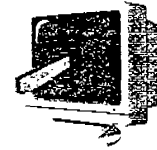


Pattern recognition screen of the n&k Analyzer 3000

附件五：AEROTECH 公司線性馬達規格

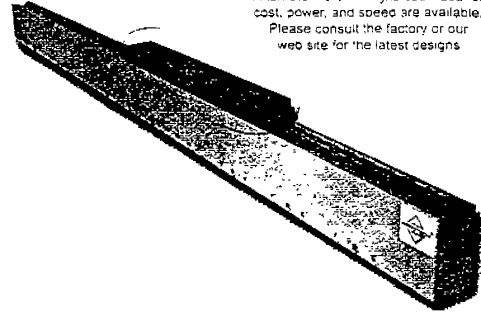
BLMH SERIES LINEAR MOTORS

Rare-Earth Magnet, Brushless Servomotors



Alternate motor designs optimized for cost, power, and speed are available. Please consult the factory or our web site for the latest designs.

- 70% greater continuous output force in the same physical envelope than competitive models
- Continuous forces up to 822 N (185 lb); peak forces to 3288 N (740 lb)
- Special magnet options available for increased force output
- 114.1 mm high x 50.8 mm wide cross section



LINEAR MOTORS


The BLMH series "U-channel" brushless linear servomotors offer over 70% greater continuous output force in the same physical envelope than similar models from other manufacturers. BLMH series motors feature a high-efficiency magnetic circuit design that provides continuous force ratings to 822 N (185 lb) and peak forces to 3288 N (740 lb). This extremely high level of performance can be enhanced with special magnet options that increase force further, thereby lowering heat generation.

BLMH series linear motors are direct drive and consist of a noncontact forcer coil assembly with Hall-effect devices, a thermal sensor, and "U-

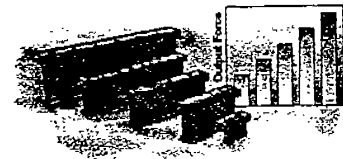
channel" magnet track. This design eliminates magnetic attraction to allow for extremely smooth motion and very tight velocity and position control. In addition, backlash, windup, wear and maintenance issues associated with ball screws, belts, and rack and pinions are eliminated.

The BLMH series nonmagnetic forcer eliminates cogging and magnetic attraction to allow for extremely smooth motion and very tight velocity and position control. These linear motors are ideal for any application that requires high speeds with high loads. BLMH series linear motors are forgiving to align, easy to assemble, and keep

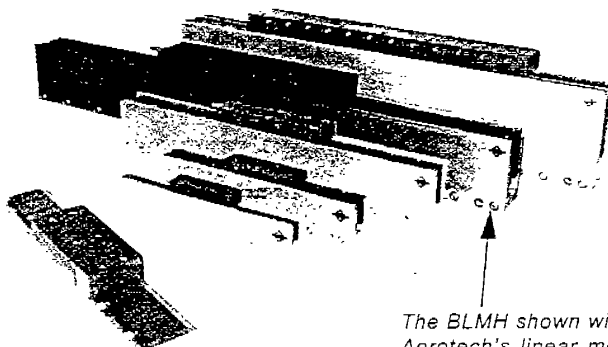
the magnetic field well-contained. Magnet tracks are stackable for any travel length. They are also suited for industrial usage.

The BLMH can be driven using standard Aerotech brushless amplifiers and controllers to provide a complete integrated system. 

AEROTECH ADVANTAGES



Multiple forcer models provide a wide output selection.



The BLMH shown with Aerotech's linear motor line.



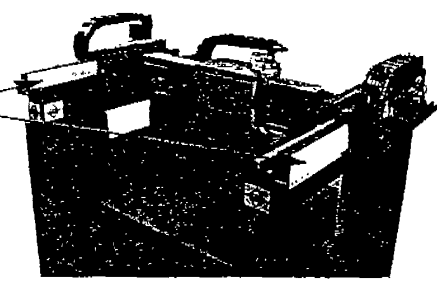
BLMH Specifications

MOTOR MODEL	Units	BLMH-142	BLMH-202	BLMH-262	BLMH-322	BLMH-382
PERFORMANCE SPECIFICATIONS						
Continuous Force @ 1.36 bar 20 psi	N lb	260.0 58.5	400.0 90.0	570.0 128.0	703.0 158.0	822.0 185.0
Continuous Force, no air	N lb	164.0 36.9	251.0 56.3	322.0 72.1	378.0 85.6	471.0 106.0
Peak Force	N lb	1040 234	1600 360	2280 512	2812 632	3288 740
ELECTRICAL SPECIFICATIONS						
Winding Designation		-A -B (opt)	-A -B (opt)	-A -B (opt)	-A -B (opt)	-A -B (opt)
BEMF, line-line	V/mvs V/in/s	31.89 63.78 0.81 1.62	47.24 94.49 1.20 2.40	65.75 131.50 1.67 3.34	79.53 159.05 2.02 4.04	50.39 101.79 1.28 2.56
Continuous Current @ 1.36 bar 20 psi	Amp _{pk} Amp _{rms}	9.19 4.60 6.30 3.25	9.48 4.74 6.70 3.35	9.76 4.88 6.90 3.45	9.90 4.95 7.00 3.50	9.90 4.95 7.00 3.50
Continuous Current, no air	Amp _{pk} Amp _{rms}	5.73 2.90 4.05 2.05	5.94 2.97 4.20 2.10	5.52 2.76 3.90 1.95	5.36 2.67 3.79 1.89	11.31 5.66 8.00 4.00
Force Constant, sine drive	N/Amp _{pk} lb/Amp _{pk}	28.28 58.57 6.36 12.73	42.43 84.85 9.48 18.95	58.48 116.97 13.08 26.16	71.42 142.84 15.98 31.96	41.72 83.44 9.23 18.74
	N/Amp _{rms} lb/Amp _{rms}	40.00 80.00 9.00 18.00	60.00 120.00 13.40 26.80	82.70 165.00 18.50 37.00	101.00 202.00 22.60 45.20	59.00 118.00 13.20 26.50
Motor Constant	N/W lb/W	14.50 3.26	17.40 3.92	20.90 4.71	22.80 5.11	24.40 5.46
Thermal @ (1.36 bar, 20 psi) Resistance (no cooling)	°C/W	0.31 0.78	0.19 0.48	0.13 0.42	0.10 0.36	0.10 0.27
Resistance, 25°C, line-line	ohms	3.7 14.8	5.5 22.0	7.3 29.2	9.1 36.4	2.8 11.0
Resistance, 125°C, line-line	ohms	5.2 20.7	7.7 31.0	10.2 40.8	12.7 50.8	3.9 15.4
Inductance, line-line	mH	2.4 9.6	3.8 15.2	4.6 18.4	6.0 24.0	1.8 7.1
Max Terminal Voltage	VDC	320	320	320	320	320
MECHANICAL SPECIFICATIONS						
Air Flow	m ³ /s SCFM	3.4x10 ⁻³ 7.7	4.1x10 ⁻³ 8.8	4.3x10 ⁻³ 9.2	4.7x10 ⁻³ 10	5.1x10 ⁻³ 10.75
Coil Weight	kg lb	1.1 2.4	1.6 3.5	2.1 4.6	2.6 5.7	3.1 6.8
Coil Length	mm in	142.0 5.6	202.0 8.0	262.0 10.3	322.0 12.7	382.0 15
Heat Sink Area [Thickness 25.4 mm (1 in)]	mm in	254x254 10x10	254x254 10x10	254x254 10x10	254x406 14x16	254x406 14x16
Magnet Track Weight	kg/m lb/ft	23.30 15.70	23.30 15.70	23.30 15.70	23.30 15.70	23.30 15.70
Magnetic Pole Pitch	mm in	30.00 1.18	30.00 1.18	30.00 1.18	30.00 1.18	30.00 1.18

LINEAR MOTORS

All Aerotech amplifiers are rated in Amp_{pk}, use force constant in Amp_{rms} when sizing.
All performance and electrical motor specifications ±10%.
Specifications at 125°C operating temperature unless otherwise specified.

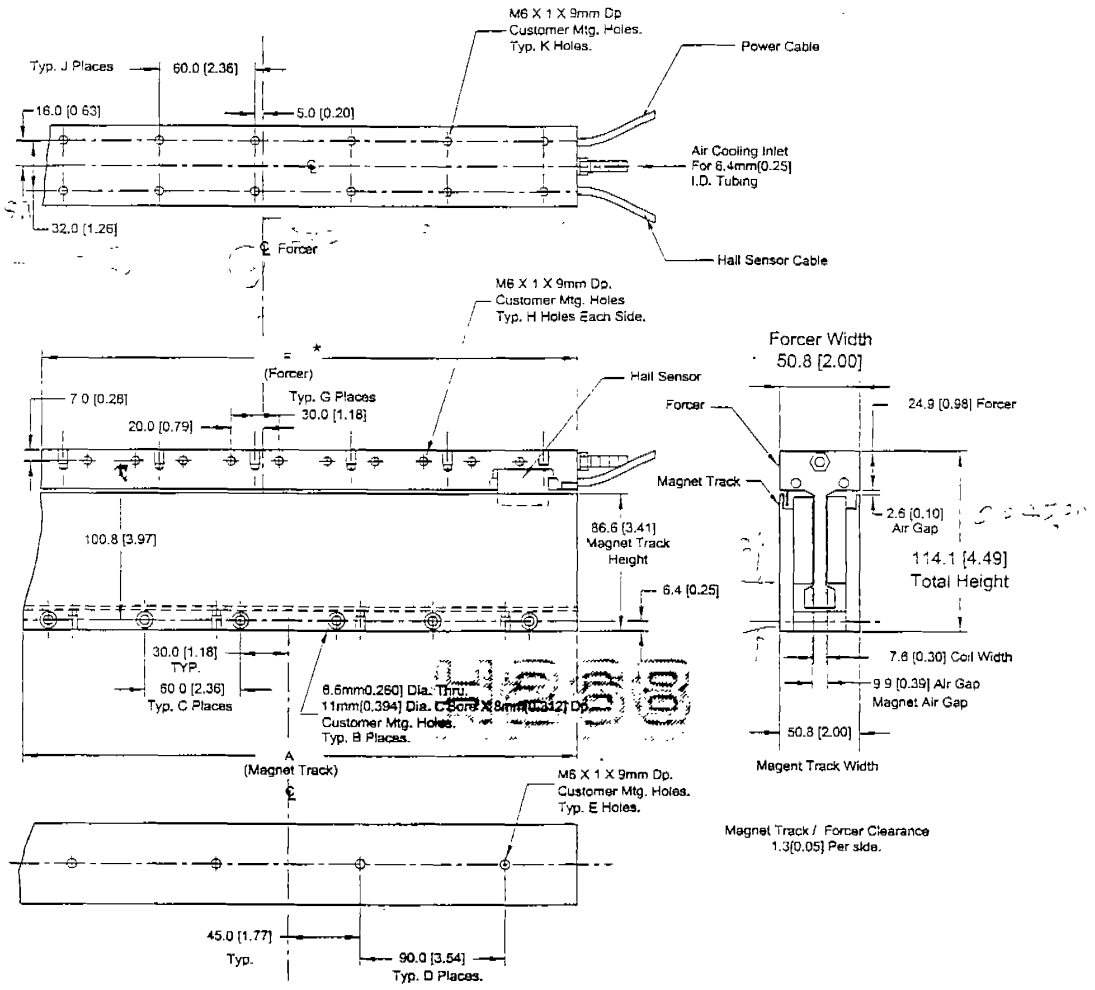
Application
BLMH linear motors used in high-performance Aerotech AGS20000 gantry system.



WORLD HEADQUARTERS: Aerotech, Inc., 101 Zeta Drive, Pittsburgh, PA 15238, USA 412-963-7470 Fax:412-963-7459 www.aerotechinc.com
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Aerotech GmbH, Süd-West-Park 90, D-90449 Nürnberg, Germany 49-911-9679370 Fax:49-911-96793720 www.aerotech-europe.com

BLMH Dimensions

LINEAR MOTORS



Magnet Track

Model No.	A	B	C	D	E
MTH360	360mm 14.17"	6	5	3	4
MTH480	480mm 18.90"	8	7	3	4
MTH600	600mm 23.63"	10	9	5	6
MTH720	720mm 28.35"	12	11	7	8

MTHx custom track lengths available

Dimensions - millimeters [inches]
Forcer

Model No.	F *	G	H	J	K
BLMH-142	142mm 5.59"	3	4	2	6
BLMH-202	202mm 7.95"	4	6	2	6
BLMH-262	262mm 10.31"	7	8	4	10
BLMH-322	322mm 12.67"	9	10	4	10
BLMH-382	382mm 15.04"	11	12	6	14

* Add 10mm(0.39) To Forcer Length for Cable Strain Relief.



The CAD can be downloaded from our web site.



BLMH Ordering Information

PART NUMBER AND ORDERING EXAMPLE: BLMH-142-A

BLMH	142	A
Motor Series	Forcer Coil Length	Standard Winding
	142 mm, 202 mm, 262 mm, 322 mm, 382 mm	76 cm (2.5 ft) flying leads std

Brushless Linear Servomotors – BLMH Series “U” Channel Forcer Coils

BLMH-142-A	Linear motor coil, with HED, air cooling, and temperature switch. Fcont=260 N (59 lb) @ 20 psi
BLMH-202-A	Linear motor coil, with HED, air cooling, and temperature switch. Fcont=400 N (90 lb) @ 20 psi
BLMH-262-A	Linear motor coil, with HED, air cooling, and temperature switch. Fcont=570 N (128 lb) @ 20 psi
BLMH-322-A	Linear motor coil, with HED, air cooling, and temperature switch. Fcont=703 N (158 lb) @ 20 psi
BLMH-382-A	Linear motor coil, with HED, air cooling, and temperature switch. Fcont=822 N (185 lb) @ 20 psi

BLMH Options

-LH ✦ Remove HED sensor from BLMH series forcer coil

“U” Channel Magnet Tracks – MTH Series for BLMH motors

MTH360	“U” channel magnet track for use with BLMH forcer coil, 360 mm (14.2 in) length
MTH480	“U” channel magnet track, for use with BLMH forcer coil, 480 mm (18.9 in) length
MTH600	“U” channel magnet track, for use with BLMH forcer coil, 600 mm (23.6 in) length
MTH720	“U” channel magnet track, for use with BLMH forcer coil, 720 mm (28.4 in) length
MTHx	Custom magnet track lengths available. Please, consult factory.

LINEAR MOTORS



We constantly improve the quality and performance of our products. Please check our web site for the most current specifications.



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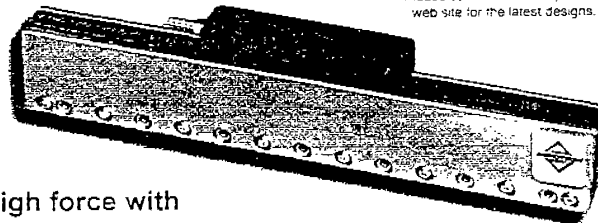
BLMUC SERIES LINEAR MOTORS

Rare-Earth Magnet, Brushless Servomotors



Alternate motor designs optimized for cost, power, and speed are available. Please consult the factory or our web site for the latest designs.

- Ultra-compact size for tight space constraints; 52.0 mm x 20.8 mm cross section
- Continuous force to 73 N (16.5 lb); peak force to 292 N (66 lb)
- Non-magnetic forcer coil provides high force with zero cogging for super-smooth velocity and position control
- Ideal for pick-and-place machines where Z-axis space is limited



The BLMUC linear motor is an ultra-compact "U-channel" motor measuring only 52.0 mm x 20.8 mm in cross section. designed to provide high force in an ultra-compact package. The BLMUC is ideally suited for small load applications with tight space constraints such as a pick head on a pick-and-place machine, and low-mass, high-acceleration material handling machines.

The motor consists of a noncontact forcer coil assembly with Hall-effect devices, thermal sensor, and "U-channel" magnet track. This design

eliminates backlash, windup, wear and maintenance issues associated with ball screws, belts, and rack and pinions.

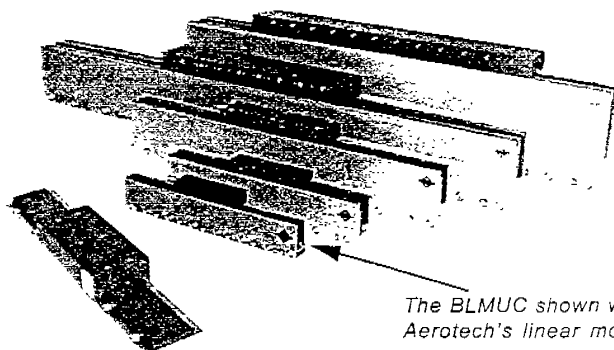
The moving forcer coil assembly is a compact, reinforced ceramic epoxy structure. The ironless design eliminates cogging and eddy-current losses that otherwise would limit speed and produce additional heat. To produce the highest rms force, air cooling is standard.

These linear motors are ideal for any application that requires high levels of positioning resolution and

accuracy. BLMUC series linear motors are forgiving to align, easy to assemble, and keep the magnetic field well-contained. Magnet tracks are stackable for any travel length. They are also suited for cleanroom use as they produce no particulates.

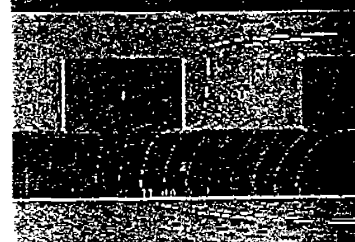
The BLMUC can be driven using standard Aerotech brushless amplifiers and controllers to provide a complete integrated system. ♦

LINEAR MOTORS



The BLMUC shown with Aerotech's linear motor line.

AEROTECH ADVANTAGES



Advanced magnetic field synthesis and analysis yields highest motor output power per unit volume.



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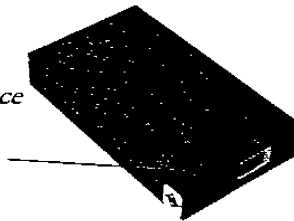
BLMUC Specifications

Motor Model	Units	BLMUC-79	BLMUC-95	BLMUC-111	BLMUC-143
PERFORMANCE SPECIFICATIONS					
Continuous Force @ 1.36 bar 20 psi	N lb	32.4 7.31	43.3 9.7	52.2 11.7	73.1 16.5
Continuous Force, no air	N lb	24.8 5.56	31.5 7.35	34.8 7.87	47.9 10.7
Peak Force	N lb	130 29.2	173 38.9	209 47	292 66
ELECTRICAL SPECIFICATIONS					
Winding Designation		-A	-A	-A	-A
BEMF, line-line	V/m/s V/in/s	7.87 0.20	10.24 0.26	12.99 0.33	18.11 0.46
Continuous Current @ 1.36 bar 20 psi	Amp _{pk} Amp _{rms}	4.54 3.21	4.37 3.39	4.54 3.21	4.54 3.21
Continuous Current, no air	Amp _{pk} Amp _{rms}	3.48 2.46	3.27 2.31	3.05 2.16	2.97 2.10
Force Constant, sine drive	N/Amp _{pk} lb/Amp _{pk}	6.97 1.60	10.04 2.24	11.60 2.60	16.05 3.61
	N/Amp _{rms} lb/Amp _{rms}	9.72 2.26	14.20 3.17	16.40 3.67	22.70 5.11
Motor Constant	N/√W lb/√W	3.50 0.79	4.30 0.96	4.45 1.00	5.20 1.18
Thermal @ (1.36 bar, 20 psi) Resistance (no cooling)	°C/W	1.15 1.97	0.98 1.71	0.71 1.57	0.49 1.36
Resistance, 25°C, line-line	ohms	4.0	5.25	6.5	8.9
Resistance, 125°C, line-line	ohms	5.6	7.3	9.1	12.5
Inductance, line-line	mH	0.51	0.70	0.87	1.10
Max Terminal Voltage	VDC	160	160	160	160
MECHANICAL SPECIFICATIONS					
Air Flow	m ³ /s SCFM	0.7x10 ⁻³ 1.53	1.1x10 ⁻³ 2.4	1.1x10 ⁻³ 2.3	1.3x10 ⁻³ 2.7
Coil Weight	kg lb	0.10 0.22	0.12 0.26	0.14 0.31	0.20 0.44
Coil Length	mm in	79.0 3.11	95.0 3.74	111.0 4.37	143.0 5.63
Heat Sink Area [Thickness 25.4 mm (1 in)]	mm in	254x254 10x10	254x254 10x10	254x254 10x10	254x254 10x10
Magnet Track Weight	kg/m lb/ft	4.04 2.72	4.04 2.72	4.04 2.72	4.04 2.72
Magnetic Pole Pitch	mm in	16.00 0.63	16.00 0.63	16.00 0.63	16.00 0.63

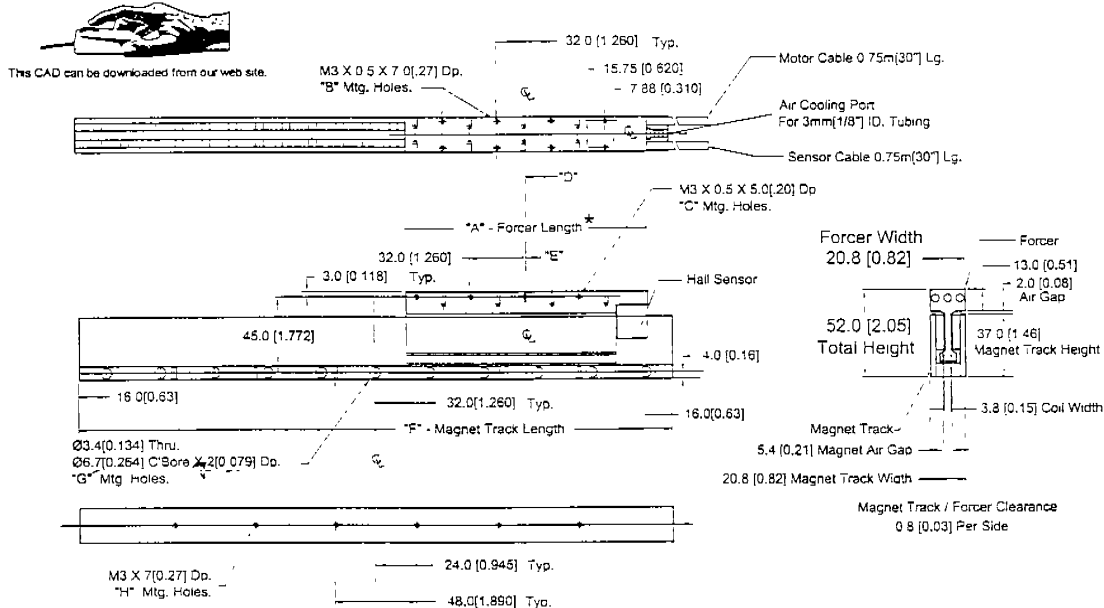
All Aerotech amplifiers are rated in Amp_{pk}; use force constant in Amp_{rms} when sizing.
All performance and electrical motor specifications ±10%.
Specifications at 125°C operating temperature unless otherwise specified.

Application

BLMUC linear motor used in high-performance Aerotech ALS130 positioning stage.



BLMUC Dimensions / Ordering Information



Magnet Track	F	G	H
Model No			
MTUC-96	96.0 [3.80]	3	2
MTUC-224	224.0 [8.82]	7	4
MTUC-352	352.0 [13.86]	11	6
MTUC-416	416.0 [16.38]	13	8

MTUCx custom track lengths available

Dimensions - millimeters [inches]						
Forcer						
Model No.	A	B	C	D	E	F
BLMUC-79	79.0 [3.11]	4	8	14.6 [0.57]	133.5 [5.27]	17.5 [0.69]
BLMUC-95	95.0 [3.74]	6	8	22.5 [0.88]	255.4 [10.05]	17.5 [0.69]
BLMUC-111	111.0 [4.37]	5	8	30.5 [1.20]	17.5 [0.69]	
BLMUC-143	143.0 [5.63]	8	8	14.5 [0.57]	15.0 [0.61]	

* BLMUC-143 Shown



Aerotech has extensive in-house design and manufacturing capabilities. Custom configurations are available for all products.

Linear Motors

PART NUMBER AND ORDERING EXAMPLE: BLMUC-79-A

BLMUC	-79	-A
Motor Series	Forcer Coil Length	Standard Winding
	79 mm, 95 mm, 111 mm, 143 mm	76 cm (2.5 ft) flying leads std

Brushless Linear Servomotors – BLMUC Series “U” Channel Forcer Coils

- BLMUC-79-A Linear motor coil, with HED, air cooling, and temperature switch, $F_{cont}=32\text{ N (7.3-lb) @ 20 psi}$
- BLMUC-95-A Linear motor coil, with HED, air cooling, and temperature switch, $F_{cont}=43\text{ N (9.7 lb) @ 20 psi}$
- BLMUC-111-A Linear motor coil, with HED, air cooling, and temperature switch, $F_{cont}=52\text{ N (11.7 lb) @ 20 psi}$
- BLMUC-143-A Linear motor coil, with HED, air cooling, and temperature switch, $F_{cont}=73\text{ N (16.5 lb) @ 20 psi}$

BLMUC Options

- LH Remove HED sensor from BLMUC series forcer coil

“U” Channel Magnet Tracks – MTUC Series for BLMUC motors

- MTUC96 “U” channel magnet track for use with BLMUC forcer coil, 96 mm (3.8 in) length
- MTUC224 “U” channel magnet track, for use with BLMUC forcer coil, 224 mm (8.8 in) length
- MTUC352 “U” channel magnet track, for use with BLMUC forcer coil, 352 mm (13.9 in) length
- MTUC416 “U” channel magnet track, for use with BLMUC forcer coil, 416 mm (16.4 in) length
- MTUCx Custom magnet track lengths available. Please consult factory

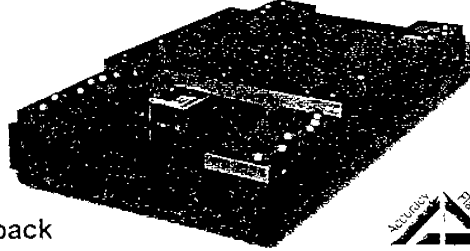


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LINEAR AIR BEARING STAGES

ABL8000

- Active air preload on all air bearing surfaces
- Integrated XY subsystems including granite
- Travel to 1 meter
- Linear encoder or laser interferometer feedback
- High stiffness for heavy loads and excellent geometrical performance



The ABL8000 was introduced to meet the needs of high-performance applications. Leading edge manufacturing, particularly in the semiconductor and data storage industries, demands positioning tolerances beyond the capability of conventional ball screw and mechanical bearing-based positioning systems.

Air Bearing Design

The ABL8000 incorporates an active preload on both vertical and horizontal surfaces. The opposing thin film pressure maintains the bearing nominal gap tolerance. This

design, in addition to the large air bearing surface that distributes the load over a large surface area, results in a stage with outstanding stiffness that is ideal for heavy or offset loading.

Proprietary manufacturing techniques result in a stage with unsurpassed geometrical characteristics. The air bearing has an inherent averaging effect that maximizes performance. The thin film will fill small surface voids and allow for other irregularities. This characteristic yields superior pitch, roll, yaw, straightness and flatness specifications.

Linear Motor Drive

The driving force behind this stage is Aerotech's BLM series brushless linear servomotor. Aerotech's long history and experience as a motor manufacturer is reflected in this design. The BLM utilizes an ironless forcer, which means there is zero cogging and no attractive forces – resulting in unsurpassed smoothness of motion. Capable of generating high force and velocity, the BLM represents the ultimate combination of power and performance.

Zero Maintenance

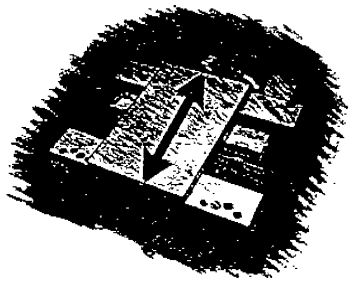
Our totally noncontact air bearing, noncontact linear motor drive, and noncontact feedback device ensure years of maintenance-free operation at the high performance levels that are expected of Aerotech equipment. Because there is no mechanical contact between moving elements, the ABL8000 experiences no wear or reduction in performance over time. Service life is virtually unlimited and since there is no lubrication – only clean, dry gas – air bearings are ideal for clean room and medical applications.

Cable Management

We carefully optimize the cable bend radius to ensure years of trouble-free operation. In the unlikely event of failure, Aerotech's modular design makes cable replacement quick and easy with minimal downtime.

To facilitate integration into the final system, we include all customer-required cables, air hoses, etc. in our CMS bundle. Both ends are fully connectorized for simple integration into the customer's machine. ♦

AEROTECH ADVANTAGES



Wide bearing spacing and a fully preloaded design gives the ABL8000 outstanding moment stiffness for maximum performance.

Accuracy	Best
Load (kg)	70 kg
Travel (mm)	1000 mm

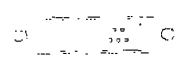


ABL8000 Series Linear Air Bearing Specifications

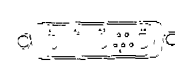
BASIC MODEL		ABL80020	ABL80030	ABL80040	ABL80050	ABL80075	ABL80100
Total Travel		200 mm (8 in)	300 mm (12 in)	400 mm (16 in)	500 mm (20 in)	750 mm (30 in)	1000 mm (40 in)
Drive System		Linear Brushless Servomotor - BLM-264-A or BLM-142-A					
Feedback		Noncontact Linear Encoder (LN or LT) or Laser Interferometer (LZR)					
Resolution	LN	0.004 μm - 0.2 μm (0.16 μin - 8 μin)					
	LT	0.02 μm - 1.0 μm (0.8 μin - 40 μin)					
	LZR	0.3 nm - 79 nm (0.012 μin - 3.2 μin)					
Maximum Travel Speed ⁽¹⁾		2 m/s (80 in/s)					
Maximum Linear Acceleration		2 g - 20 m/s ² (768 in/s ²) (no-load)					
Maximum Load ⁽²⁾		70.0 kg (154.0 lb) to 140.0 kg (208.0 lb)					
Continuous Stall Force ^(3,4)	Air (20 psi)	BLM-264-A - 276.0 N (62.0 lb); BLM-142-A 168.0 N (37.9 lb)					
	No Air	BLM-264-A - 207.0 N (46.4 lb); BLM-142-A 109.0 N (24.6 lb)					
Peak Force ⁽⁴⁾		BLM-264-A - 1106.0 N (248.0 lb); BLM-142-A 673.0 N (151.0 lb)					
Overall Accuracy	LN	HALAR ⁽⁵⁾	$\pm 0.5 \mu\text{m}$ ($\pm 20 \mu\text{in}$)		$\pm 0.75 \mu\text{m}$ ($\pm 30 \mu\text{in}$)		$\pm 1.0 \mu\text{m}$ ($\pm 40 \mu\text{in}$)
		Standard	$\pm 5.0 \mu\text{m}$ ($\pm 200 \mu\text{in}$)				
	LT	HALAR ⁽⁵⁾	$\pm 0.5 \mu\text{m}$ ($\pm 20 \mu\text{in}$)		$\pm 0.75 \mu\text{m}$ ($\pm 30 \mu\text{in}$)		$\pm 1.0 \mu\text{m}$ ($\pm 40 \mu\text{in}$)
		Standard	$\pm 8.0 \mu\text{m}$ ($\pm 320 \mu\text{in}$)	$\pm 12.0 \mu\text{m}$ ($\pm 480 \mu\text{in}$)	$\pm 16.0 \mu\text{m}$ ($\pm 640 \mu\text{in}$)	$\pm 24.0 \mu\text{m}$ ($\pm 960 \mu\text{in}$)	$\pm 30.0 \mu\text{m}$ ($\pm 1200 \mu\text{in}$)
LZR	Standard $\pm 10 \text{ ppm}$; Compensated $\pm 1.5 \text{ ppm}$ ⁽⁶⁾						
Repeatability	LN	$\pm 0.2 \mu\text{m}$ ($\pm 8 \mu\text{in}$)			$\pm 0.3 \mu\text{m}$ ($\pm 12 \mu\text{in}$)	$\pm 0.4 \mu\text{m}$ ($\pm 16 \mu\text{in}$)	
	LT	$\pm 0.2 \mu\text{m}$ ($\pm 8 \mu\text{in}$)			$\pm 0.3 \mu\text{m}$ ($\pm 12 \mu\text{in}$)	$\pm 0.4 \mu\text{m}$ ($\pm 16 \mu\text{in}$)	
Straightness and Flatness	Differential	0.25 $\mu\text{m}/25 \text{ mm}$ (10 $\mu\text{in}/\text{in}$)			0.50 $\mu\text{m}/25 \text{ mm}$ (20 $\mu\text{in}/\text{in}$)		
	Maximum Deviation	$\pm 0.4 \mu\text{m}$ ($\pm 16 \mu\text{in}$)	$\pm 0.75 \mu\text{m}$ ($\pm 30 \mu\text{in}$)	$\pm 1.5 \mu\text{m}$ ($\pm 60 \mu\text{in}$)	$\pm 2.0 \mu\text{m}$ ($\pm 80 \mu\text{in}$)	$\pm 3.0 \mu\text{m}$ ($\pm 120 \mu\text{in}$)	$\pm 4.0 \mu\text{m}$ ($\pm 160 \mu\text{in}$)
Pitch / Roll / Yaw		0.25 arc sec/25 mm					
Operating Pressure ⁽⁷⁾		80 psi ± 5 psi					
Air Consumption ⁽⁸⁾		< 2 cfm @ 80 psi					
Nominal Stage Weight		70.0 kg (154.3 lb)	77.0 kg (169.8 lb)	85.5 kg (188.5 lb)	93.5 kg (206.1 lb)	113.0 kg (249.1 lb)	131.5 kg (289.9 lb)
Material		Aluminum					
Finish		Hard Coating (62 Rockwell Hardness Teflon Impregnated)					

- Notes:
1. Maximum speed based on stage capability; maximum application velocity may be limited by system data rate and system resolution.
 2. Maximum load based on bearing capability; maximum application load may be limited by acceleration requirements.
 3. Thermal limitations of positioning stage with respect to performance may limit continuous force output.
 4. Force may be limited by amplifier output.
 5. Available with UNIDEX series controller.
 6. Requires environmental compensation. See LZR section for more information.
 7. To protect air bearing against under-pressure, an in-line pressure switch tied to UNIDEX 500 / 800 E-stop input is recommended.
 8. Air supply must be clean, dry to 0° F dewpoint and filtered to 0.25 μm or better; recommend nitrogen at 99.9% purity.

STANDARD MOTOR INFORMATION - LC CARRIAGE WITH -10 MOTOR

CODE	TYPE	MODEL	BUS	AMPS	CABLE	DRIVER	MOTOR CONNECTOR
-10	Linear Brushless Servo	BLM-264-A	up to 320 VDC	up to 6.2 A _{rms} Cont up to 24.8 A _{rms} Peak	BMCHPD / BFCMX	U511 / DR500 / DR600	
					PMCHPD / BFCMX	BB501 + BA	
					BMP2HPD / BFCMX	BAJ	
						U100Z	







STANDARD MOTOR INFORMATION - SC CARRIAGE WITH -5 MOTOR

CODE	TYPE	MODEL	BUS	AMPS	CABLE	DRIVER	MOTOR CONNECTOR
-5	Linear Brushless Servo	BLM-142-A	up to 320 VDC	up to 3.8 A _{rms} Cont up to 15.0 A _{rms} Peak	BMCHPD / BFCMX	U511 / DR500 / DR600	
					PMCHPD / BFCMX	BB501 + BA	
					BMP2HPD / BFCMX	BAJ	
						U100Z	

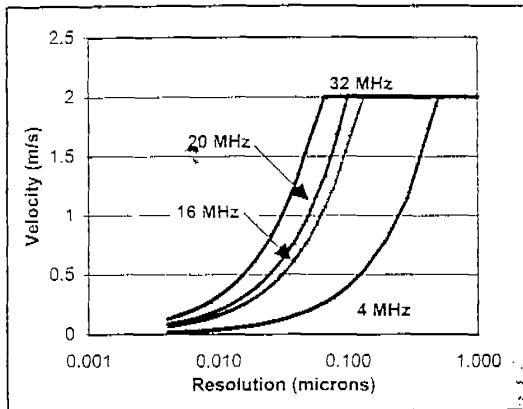


ABL8000 Series Linear Air Bearing Specifications

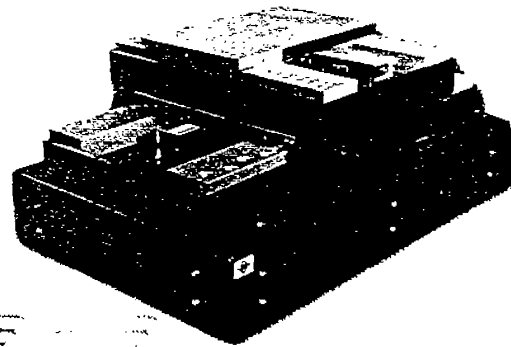
RESOLUTION INFORMATION

CODE	SIGNAL PERIOD	TRAVEL / STEP	MULTIPLIER	MAXIMUM SPEED	SIGNAL TYPE	ENCODER CONNECTOR
LN	4 μm	0.004 μm - 0.2 μm	Requires External	System Data Rate		
LZR	316.5 nm	79 nm	Integral $\lambda/8$	1 m/s ⁽¹⁾		
LZR	316.5 nm	0.3 nm - 15.8 nm	Requires External	System Data Rate		

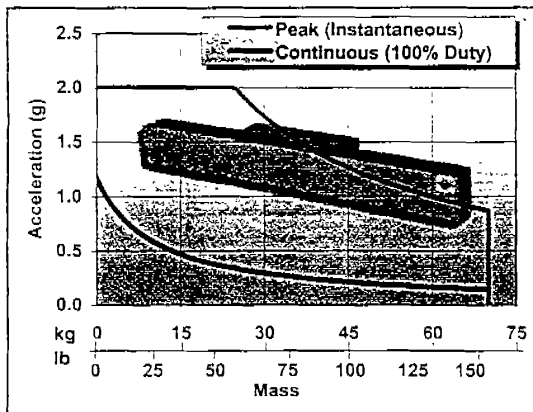
Notes: 1. Requires system data rate of at least 14 MHz.



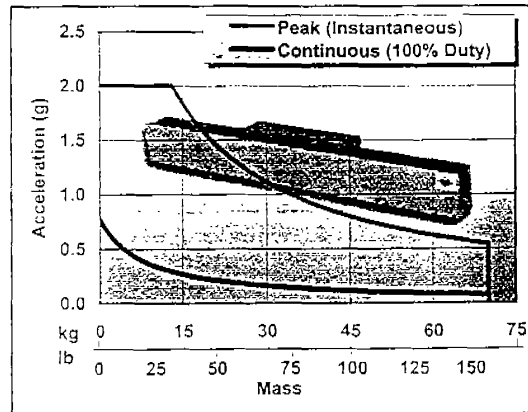
Velocity vs. Resolution as a function of system data rate (ABL8000 with LTAS or LNAs encoder)



The ABL8000 is typically provided as a complete xy assembly with integrated cable management for customer cabling, as well as a granite mounting base.



Acceleration vs. Mass (ABL8000-LC with BLM-264-A motor).

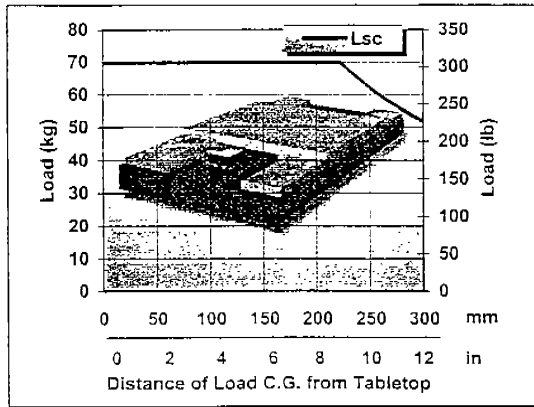


Acceleration vs. Mass (ABL8000-SC with BLM-142-A motor).

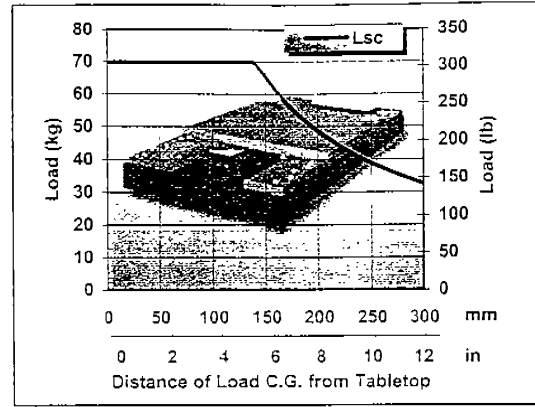


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ABL8000 Series Linear Air Bearing Specifications



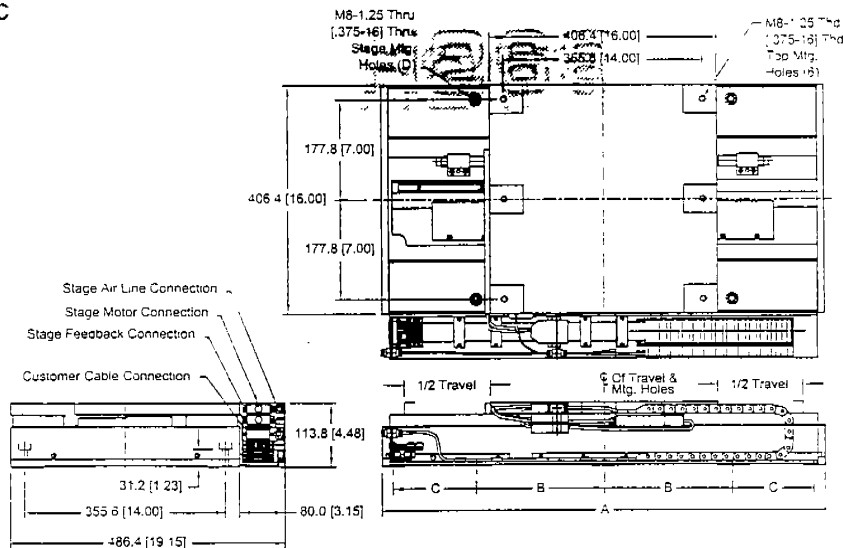
L_{vc} and L_{sc} Cantilevered Load Capacity (ABL8000-LC)



L_{vc} and L_{sc} Cantilevered Load Capacity (ABL8000-SC)

ABL8000 Linear Air Bearing Dimensions

ABL8000 - LC



Basic Model	Total Travel	Dimensions - Millimeters [Inches]			
		A	B	C	D
ABL80020-LC	200.0 [8.00]	885.6 [27.00]	228.6 [9.00]	-	5
ABL80030-LC	300.0 [12.00]	787.4 [31.00]	228.6 [9.00]	-	5
ABL80040-LC	400.0 [16.00]	889.0 [35.00]	228.6 [9.00]	-	5
ABL80050-LC	500.0 [20.00]	990.6 [39.00]	228.6 [9.00]	-	5
ABL80075-LC	750.0 [30.00]	1244.6 [49.00]	228.6 [9.00]	285.8 [11.25]	10
ABL80100-LC	1000.0 [40.00]	1498.6 [59.00]	228.6 [9.00]	285.8 [11.25]	10

 CADs can be downloaded from our web site.

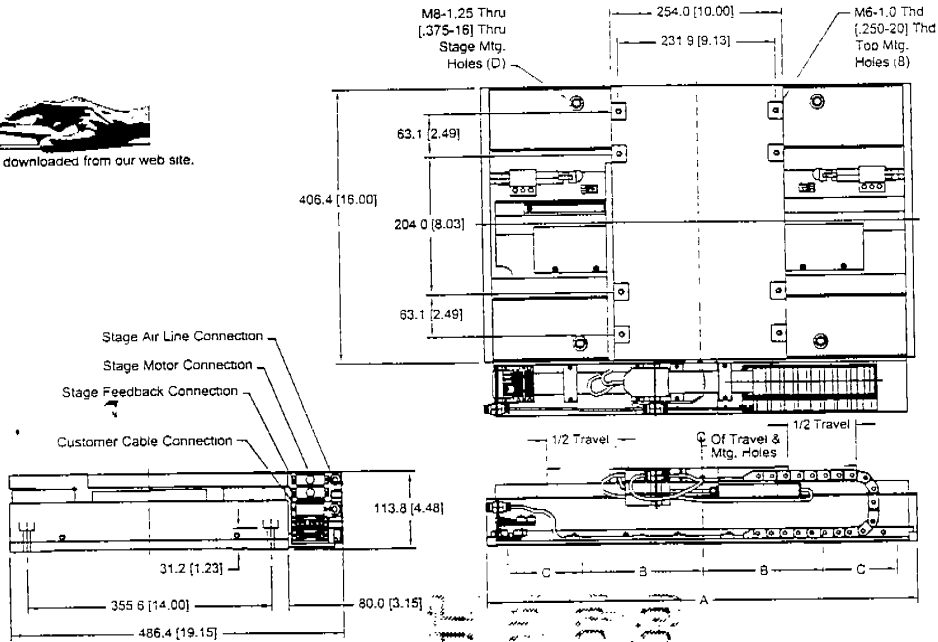


ABL8000 Series Linear Air Bearing Dimensions

ABL8000 - SC



CADs can be downloaded from our web site.



Basic Model	Total Travel	Dimensions - Millimeters [Inches]			
		A	B	C	D
ABL80020-SC	200.0 [8.00]	533.4 [21.00]	177.8 [7.00]	-	6
ABL80030-SC	300.0 [12.00]	635.0 [25.00]	177.8 [7.00]	-	6
ABL80040-SC	400.0 [16.00]	736.6 [29.00]	228.6 [9.00]	-	6
ABL80050-SC	500.0 [20.00]	838.2 [33.00]	228.6 [9.00]	-	6
ABL80075-SC	750.0 [30.00]	1092.2 [43.00]	228.6 [9.00]	285.8 [11.25]	10
ABL80100-SC	1000.0 [40.00]	1346.2 [53.00]	228.6 [9.00]	285.8 [11.25]	10



Aerotech has extensive in-house design and manufacturing capabilities. Custom configurations are available for all products.

Air Bearings



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