

出國報告（出國類別：參加研討會）

出席 Pacific Rim Meeting On
Electrochemical and Solid-State Science2016
(2016世界電化學及固態科學研討會-夏威夷)
心 得 報 告

服務機關：國防大學理工學院動力及系統工程學系
姓名職稱：王樂民教授
派赴國家：美國夏威夷
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摘要

世界電化學及固態科學研討會 (Pacific Rim Meeting On Electrochemical and Solid-State Science 2016)為國際間重要會議，每四年於夏威夷舉行一次，如主辦單位宣稱，是世界上最大型極為重要的研討會，會議摘要歷經審查機制才通知是否接受及邀請海報論文發表或口頭發表。

此會議參與學者遍及世界各國，學者研究範圍極廣，學術討論分為：

- A.電池及能源科技, B.碳化物奈米結構 C.氧化物及腐蝕特性 D.光電(Photovoltaics)E.電漿奈米科技及技術，磁性材料製程及元件，固-液相介面與電沉積之影響，電沉積在能源技術上的應用
- F.工業級電化學應用與工程，電化學創新應用實測研討
- G.高純度半導體、半導體、介電材料，金屬在奈米電子上的應用，鍍及相關元件製程，化合物半導體，晶圓接合科技及技術，薄膜電晶體
- H.較低次元光電元件，氫化鉀科技，微流體及奈米流體元件，奈米材料及元件
- I.燃料電池高分子電解質，固態離子元件，燃料合成反應，水與能源關連(自含鹽的溶液取出動力)，發光即顯示材料基礎及應用
- J.固態照明材料
- K.生化工程與電化學應用，電化學在有機化學及生物工程近來的應用及面對的問題，物性，分析，電化學催化，光電電化學
- L.融化鹽類及離子液體
- M.化學感測器，微機電微細製造，奈米材料及元件電化學分析……等，範圍極廣，內容豐碩。

本議程計有 3 場 Plenary Session 報告，5 場 Invited Speakers 報告，上千篇的口頭報告，內容極為豐碩。

本人發表 “The effect of Thermal Hydrogenation Processing on the nano-size Grain refinement, mechanical property and corrosion of Ti-6Al-4V alloy” 以調整儲氣吸收量的參數來評估及了解形成奈米晶粒的可能機制，並探討其機械性能及耐蝕能力。與會學者，評價良好，會後收到會議主席來謝函表示感謝貢獻該研討會之努力。經與國際間專家研討，對未來研究方向精進，極有助益。近日也收到與此研討會需投稿之 ECS transaction 主編來函正面評價此論文，只要稍作微小修正，即能獲刊登於該期刊，更感此行收穫良多。

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目的

- 1.赴美國研討會，發表研究成果。
- 2.與國際學者進行學術交流。

過程

此次研討會於 105 年 10 月 2-7 日假美國夏威夷 Convention center 舉行，計有大會演講論壇、論文報告及論文海報展示及說明等項。此次研討範圍如下:

- A.電池及能源科技, B.碳化物奈米結構 C.氧化物及腐蝕特性 D.光電(Photovoltaics) E.電漿奈米科技及技術，磁性材料製程及元件，固-液相介面與電沉積之影響，電沉積在能源技術上的應用 F.工業級電化學應用與工程，電化學創新應用實測研討
G.高純度半導體、半導體、介電材料，金屬在奈米電子上的應用，鍍及相關元件製程，化合物半導體，晶圓接合科技及技術，薄膜電晶體
H.較低次元光電元件，氫化鉀科技，微流體及奈米流體元件，奈米材料及元件
I.燃料電池高分子電解質，固態離子元件，燃料合成反應，水與能源關連(自含鹽的溶液取出動力)，發光即顯示材料基礎及應用
J.固態照明材料
K.生化工程與電化學應用，電化學在有機化學及生物工程近來的應用及面對的問題，物性，分析，電化學催化，光電電化學
L.融化鹽類及離子液體
M.化學感測器，微機電微細製造，奈米材料及元件電化學分析……等

10 月 1 日開始接受與會人員報到及論文海報展示備便。10 月 2 日 16:00 為大會開幕式，8:05 時起由大會邀請之 Dr.R.KDixton,美國能源部門主管就 DOE' s Effects to accelerate the Federally-Funded Technology to the marketplace 進行開場，開始一連串大會及分組議題報告，依大會規劃之場地就各議題實施分組報告與意見交流，最後大會於 10 月 7 日 1700 時舉行圓滿閉幕。

本人獲得邀請之論文口頭報告，大會安排於 10 月 5 日 1200-1220 時，由 Section chair, Prof .Kazuhisa Azumi 主持，此講壇演講主題為“Oxide Formation and Applications”，進行“The effect of Thermal Hydrogenation Processing on the nano-size Grain refinement, mechanical property and corrosion of Ti-6Al-4V alloy” 論文口頭報告，(附件一)。嘗試以 Ti-6Al-4V 合金經由先前熱置氫製程調整吸氣量為參數，長出之奈米晶粒的機制進行深入探討，以期未來更能掌握長在此奈米晶粒上的氧化層；並探討其耐蝕性能，及不同吸氣參數下的機械性質。研究結果顯示奈米晶粒形成機制被提出，與會學者及主持人也認同此一新結果，對腐蝕性能影響，機械性質也符預期。報告結束獲與會學者及主持人積極提問並獲滿意答覆。其中所提問題概分為：

- (1)為何會想到利用此方法？
- (2)差排環是如何產生？
- (3)ill-designed area 的觀察與 amorphous 有何不同？
- (4)即是奈米晶粒、硬度表現如何？

本人逐一回答並解釋，或提問人表達同意，互動良好；會後回台灣後收到會議主席來謝函表示感謝貢獻該研討會之努力。經與國際間專家研討，對未來研究方向精進，極有助益。近日也收到與此研討會需投稿之 ECS transaction 主編來函正面評價此論文，只要稍作微小修正，即能獲刊登於該期刊，更感此行收穫良多。

心得及建議

經過此次研討會，看到國際間研發大量投入能源領域，令人印象深刻。在大會會場，更看到各項先進的研究及量測設備技術與展示，也深感國際間競爭與日俱增，我國必須投入相當的研究經費及資源以使國家具競爭力。

經過此次四年一次的國際研討會，深覺教學研究的責任重大，每出國乙次，更覺責任重大。

看到國外學者及對岸中國大陸的研究成果，國內在研究主題上實應集中有效火力，分析最有利我國的大方向，全力推行之。對材料科技之掌握，實應繼續戮力以赴，一定要大量投入資源提升研究能力，掌握製程技術，以電腦技術模擬，精進製程，結合微觀結構分析以改進其機械性質是為必走之方向，更可提升材料性能。目前由於 Ti 合金可投入航空，國防工業及生醫等重要工業，且可結合節能省碳因應潮流及工業需求；亦感我國學人及產學可投入更多能力、經費，使具有國際競爭力，國內相關產業及研究方向亦應朝材料科學減重強化發展。

將來學生也與世界接軌，未來更當於學生報告中，半強迫及鼓勵其以英文報告，撰寫研究成果提升英文能力。

Oxygen generation from ^{18}O isotope-doped Li_2CuO_2 caused by electrochemical oxidation

Tomoyuki Ozeki, Yu Taura, Kazuko Yamashita, Ryuichi Arakawa, Hideya Kawasaki, Yoshinori Arachi
Department of Chemistry, Materials Engineering, Kansai University,
3-3-5 Yamatecho, Suita, Osaka 564-8680, Japan

Li-ion batteries with high energy density have been required for power sources of electric vehicles. In particular, it is crucial that the positive electrodes exhibit a large specific capacity with high cell voltage. The practical candidates for the electrode are limited such as LiMnO_2 -based solid solutions. Based on our previous investigations on $\text{LiNi}_{1-x}\text{Mn}_x\text{O}_2$, we have focused on Li_2CuO_2 and $\text{Li}_2\text{Cu}_{1-x}\text{Ni}_x\text{O}_2$ solid solutions to investigate the role of oxygen in the positive electrode.

Background

- Characterization of copper oxide
 - ^{18}O plane is spread into a sheet
 - Energy level of CuO is close to that of Cu $^{2+}$
 - Apply to the Li-ion batteries
 - Overlap of Cu 3d and O 2p orbitals indicates the possibility of oxygen to involve in removing lithium
- Characterization of Li_2CuO_2
 - High temperature superconductivity
 - Energy band structure
 - Large irreversible capacity by CuO
- Synthesis of ^{18}O isotope-doped Li_2CuO_2 and $\text{Li}_2\text{Cu}_{1-x}\text{Ni}_x\text{O}_2$ samples
 - Set up for in situ GC-MS
 - Detection method of oxygen (mass spectrometry)

Results and Discussion

- Various gases generation in the first charge process
 - Specific capacity ratio
 - Charge and discharge capacity of Li_2CuO_2 - Li_2NiO_2
- Phase changes in Li_2CuO_2 system charge process
 - $\text{Li}_2\text{CuO}_2 \rightarrow \text{CuO} + 1/2\text{O}_2$
 - $\text{Li}_2\text{Cu}_{1-x}\text{Ni}_x\text{O}_2 \rightarrow \text{Li}_2\text{Cu}_{1-x}\text{Ni}_x\text{O}_{2-y} + y/2\text{O}_2$
 - Objectives
 - To detect O_2 release directly from Li_2CuO_2 by use of GC-MS analysis.
 - To discuss the role of the oxygen on the electrochemical mechanism of Li_2CuO_2 .

Conclusion

A single phase of Li_2CuO_2 was confirmed by XRD and TEM.

Non-pressure Joining Method for Zn-Al Solder By Pre-Ultrasonic Bonding

Hidekazu Tanisawa^{1,2}, Hiroki Takahashi³, Fumiki Kato⁴, Kenichi Koihi⁴, Shiro Saito⁵, Yoshinori Murakami⁶, Hiroshi Sato⁷

¹National Institute of Advanced Industrial Science and Technology, ²Sanken Electric Co., Ltd., ³Fuji Electric Co., LTD, ⁴Dalsonic Kansai Corp., ⁵Nissan Motor Co., Ltd.

Background

- Restrictions during reflow of Zn-Al preform solder
 - Cu finish on the plated Ni
 - Diffuse in a vacuum
 - Fail during reflow (>5g/min)
 - Quality performs than die
- Need to break the oxide film

Proposed technique

- Ultrasonic bonding to circuit board
- Ultrasonic bonding to chip
- Ultrasonic bonding to solder joint

Result of jointing

- Image after shear test
- Cross-sectional SEM image of interface for type 2
- Share strength each condition

Conclusion

Zn-Al solder preform joining process above 250 °C for Sn-chips was developed using ultrasonic bonding before reflow.

ZnO nanowire device fabricated by hydrothermal synthesis and dielectrophoresis method for gas sensor applications

Cheng-Han Lyy, Kai-Heng Sun, Yu-Hung Wang, Hsun-Feng Hsu¹
Department of materials science and engineering, National Chung Hsing University, Taichung 402, Taiwan, R.O.C.
¹E-mail: hhsu@dragon.nchu.edu.tw

ZnO nanowires were synthesized on the ZnO seed layer by hydrothermal method. The alternating current electrical field was used to align ZnO nanowires of different lengths between the electrodes. The results show that a flat surface and small grain of seed layer was received by annealing at 300 °C, and it can be used to fabricate ZnO nanowires with small fluctuation in length and width layer by hydrothermal method. ZnO nanowires had the highest aspect ratio when the concentration of precursors was 0.04M. The length of nanowires increases by adding an appropriate concentration of Polyethyleneimine (PEI). In the process of ZnO nanowires alignment by dielectrophoresis method, the parallel and crossed ZnO nanowire-based devices were achieved by adjusting the frequency and the peak-to-peak voltage of alternating current electrical field. For the CO sensing, the sensing sensitivity and limit-of-detection of the crossed nanowire-based devices were better than the parallel nanowire-based ones due to the potential barrier modulation at the nanojunctions between two nanowires.

ZnO seed layer preparation

Parallel nanowires based ones fabricated by dielectrophoresis method with 1 V AC electrical field and a frequency of 10 KHz.

Crossed nanowires based ones fabricated by dielectrophoresis method with 5 V AC electrical field and a frequency of 1 KHz.

ZnO nanowires growing

The grain size and roughness of seed layer by annealing at 300 °C were studied.

CO Sensing properties of ZnO nanowire devices

The sensing sensitivity and limit-of-detection of the crossed nanowire-based devices were better than the parallel nanowire-based ones due to the potential barrier modulation at the nanojunctions between two nanowires.

Synthesis of Alternate Layered Structure of Ruthenate Nanosheet-Graphene Oxide for Electrochemical Applications

Dai Mochizuki, Keita Ishimoto, Yusuke Ayato, Wataru Sugimoto

SUMMARY

As a power storage device with performances of rapid charge/discharge, long-life and high power density, electrochemical capacitor is receiving attention. As high power density materials, there are two types of materials: (1) carbon materials such as activated carbon, reduced graphene oxide (rGO), and carbon nanotube and (2) metal oxide materials such as RuO₂ and MnO₂. Studies have also been conducted to improve specific capacitance by supporting metal oxide on carbon materials. We focus on the combination of RuO₂ nanosheet which has a high pseudocapacitance, with GO which has a high on conductivity to enhance electrochemical performance.

INTRODUCTION

Formation of alternating metal oxide layers with different interlayer distances by changing the functional groups

Purpose of This Study

RESULTS and DISCUSSION

Modification of alkylthiol groups on layered ruthenates

Experimental Procedure

EDX analysis

APM images

TEM images

Click Reaction of alkylthiol-modified ruthenate nanosheet with GO

Experimental Procedure

Raman

XRD patterns

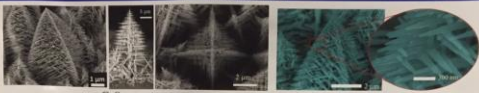
Formation of C318H-RuO₂ nanosheets

Formation of GO-C318H-RuO₂ Alternating Layered Structure

Oxidation of CuSn alloy nano-tree and application for gas sensors

N. Kaneko*, T. Shimizu*, T. Ito*, Y. Tada**, S. Shingubara*

*Graduate School of Science and Engineering, Kansai University, Suita, Osaka 564-8680, Japan
**Muroran Institute of Technology, Muroran, Hokkaido 050-0071, Japan
E-mail: nkaneko@ipc.kansai-u.ac.jp

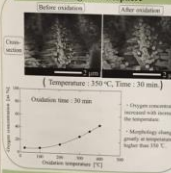


CuSn nanotree

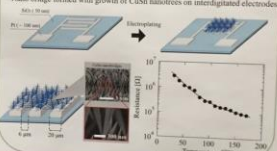
Nanotree is a tree three-dimensional (3D) nano structure with many branches that separate from trunk perpendicularly, and sub-branches grow perpendicularly from these also. Nanotree is formed by DC electrolyzing with a constant potential mode. [1] Nanotree is formed by DC electrolyzing with a constant potential mode. [1]

1. Formation of CuSn nanotree oxide by anodizing in atmosphere.
2. Evaluation of electrical properties of CuSn nanotree oxide.
3. Evaluation of gas sensing properties of CuSn nanotree oxide.

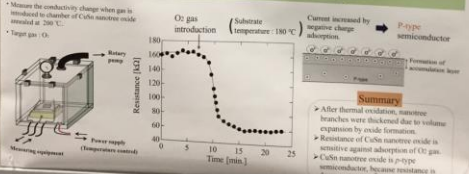
Formation of CuSn nanotree oxide by anodizing in atmosphere



Temperature dependence of the resistance of CuSn nanotree oxide



Gas sensing property of CuSn nanotree oxide



After thermal oxidation, nanotree branches were thickened due to volume expansion by oxide formation.
Resistance of CuSn nanotree oxide is sensitive against adsorption of O2 gas.
CuSn nanotree oxide is p-type semiconductor, because resistance is decreased with O2 gas adsorption.

bioinformatics

Micro printing of metal nanoparticles for printed biodegradable devices

MOTIVATION Trillion sensor universe
1) Low cost (ca. \$ 0.01 - 0.001); Printing.
2) Low environmental impact: Biodegradable.

SUMMARY we developed printed pattern of metal nanoparticles on biodegradable polymer substrate



Detail

(1) 80 polymer: PLA, PCL, PHBV, PCL, PHBV, PHBV. Preparation of 80 film. Template printing.

(2) Preparation of 80 film: PLA Front Back, PCL Front Back, PHBV Front Back.

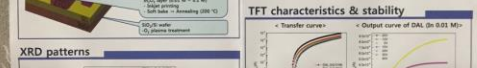
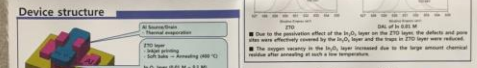
(3) Template printing: Printing metal nanoparticles on the biodegradable polymer substrate.

Acknowledgement: This research was partially financially supported by the Ministry of Education, Culture, Sports, Science and Technology of Japan.

Inkjet-Printed Oxide Thin-Film Transistors Using Double-Active Layer Structure

Sung-Hyun Lee, Young-In Kwak, Hunho Kim and Woon-Suep Cho*
Dept. of Display Engineering, Hoseo University, Asan, Chungnam 336-795, South Korea
Nano Organic Electronics Lab (NOEL)

Abstract
Inkjet printed oxide thin-film transistors were prepared by inkjet printing double active layer structure on SiO2/Si substrate. The active layer was composed of ZnO and In2O3. The channel length of the device was 100 μm and the channel width was 10 μm. The device showed a maximum field-effect mobility of 1.5 cm²/Vs and a maximum current density of 1.5 mA/cm². The device showed a maximum field-effect mobility of 1.5 cm²/Vs and a maximum current density of 1.5 mA/cm².



Active layer	μ _{FE} (cm²/Vs)	I _{ON} (mA/cm²)	I _{OFF} (nA/cm²)	V _{th} (V)
ZnO	0.5	1.5	0.1	0
In ₂ O ₃	1.5	1.5	0.1	0
ZnO/In ₂ O ₃	1.5	1.5	0.1	0

Conclusions
Inkjet printed oxide thin-film transistors were prepared by inkjet printing double active layer structure on SiO2/Si substrate. The active layer was composed of ZnO and In2O3. The channel length of the device was 100 μm and the channel width was 10 μm. The device showed a maximum field-effect mobility of 1.5 cm²/Vs and a maximum current density of 1.5 mA/cm².

References

1. S. H. Lee, Y. I. Kwak, H. Kim, and W. S. Cho, "Inkjet-Printed Oxide Thin-Film Transistors Using Double-Active Layer Structure," *Journal of Applied Physics*, vol. 112, no. 12, pp. 124702, Dec 2012.

2. S. H. Lee, Y. I. Kwak, H. Kim, and W. S. Cho, "Inkjet-Printed Oxide Thin-Film Transistors Using Double-Active Layer Structure," *Journal of Applied Physics*, vol. 112, no. 12, pp. 124702, Dec 2012.

Optimization of Poly(3,4-ethylenedioxythiophene):Poly(4-styrenesulfonate) Electrodes Using Electrohydrodynamic Printing Process

Eun Mi Jung, So Hyun Park, Se Hyun Kim, Seung Woo Lee*
School of Chemical Engineering, Yeungnam University, 280 Daehak-Ro, Gyongsan, 712-749, Republic of Korea
leesww1212@ynu.ac.kr

Introduction

Organic thin-film transistors (OTFTs) / Source-Drain electrode for OTFTs / Digital printing process / Electrohydrodynamic (EHD) printing

Experimental

Electrohydrodynamic (EHD) printing process / Preparation of PEDOT:PSS/ surfactant solution / Contact angle measurement

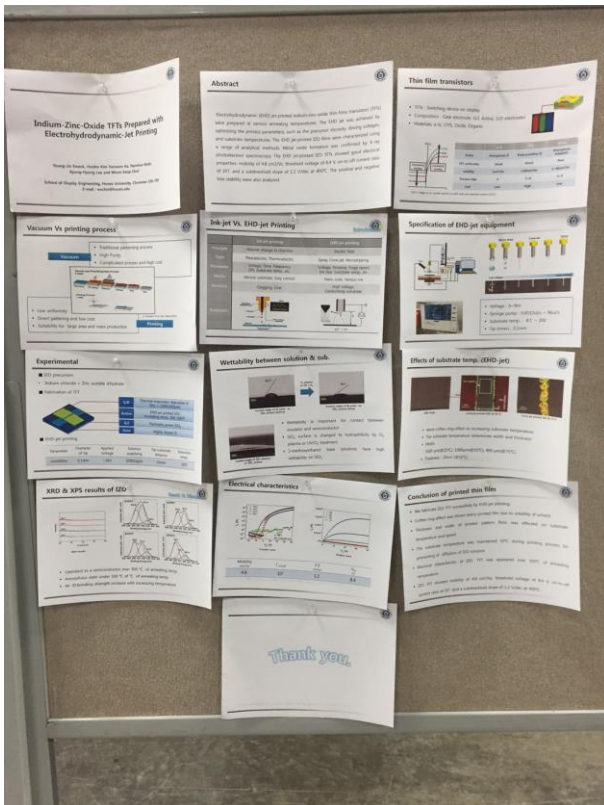
Results and Discussion

Approaching micro-dripping mode / Process parameters to achieve micro-dripping mode in EHD printing process / Relationship between the width and flow rate

Acknowledgments / **Conclusions**

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (NRF-2014R1A5A1A01052001).

In this paper, we experimentally investigated the effects of a surfactant on the surface tension of a PEDOT:PSS solution for use in the EHD printing process. By modifying the surface tension with the addition of a cationic surfactant, we demonstrated that the EHD printing method could be used to a specific printing mode, such as the micro-dripping mode, at low pressure. The printed electrode could be controlled by manipulating the flow rate. We also demonstrated that the conductivity of the PEDOT:PSS solution could be enhanced by a factor of 300, by adding the polymer surfactant for electrode fabrication in functional devices.



[H03-2166] Operational Amplifier Circuits with Oxide Thin Film Transistors

In Hye-Kang¹, Min-Tack Hong¹, Jong-Mo Lee¹, and Byung-Seong Ra²
¹Dept. of Display Engineering, Hoseo University, Asan, Chungnam 31499, Korea
 Tel: 82-41-546-5251; E-mail: hkyk@hoseo.edu
²Dept. of NanoBioTronics, Hoseo University, Asan, Chungnam 31499, Korea

Introduction

- The a-Si:H TFT is not suitable for an integrated circuit on a high resolution backbone due to the low charge carrier mobility. Oxide TFTs are replacing the a-Si:H TFTs because of low cost process, the higher mobility and lower leakage current than a-Si:H TFT. Since only the n-channel is available in an a-IGZO TFT, complementary circuit with both the N and P channel TFTs are not possible.
- One of the popular circuit is op-amp which can be used for the amplification of the analog signal or for the comparator. The measurements of sensing signal require an amplifier such as an op-amp and also comparators for the analog to digital converting. And also the circuits need a low-power consumption to enable a long use of the battery, and a small circuit area for the low cost and compact packaging. With above improvement of the technologies, one of the applications of TFT integrated circuits is inexpensive health diagnostics.
- Most of the analog circuit is adopting a CMOS-based op-amp for the excellent performance. TFTs can be used for the integrated circuits on the glass or the flexible substrate instead of attaching the chips on the substrate. For the sensing applications, we developed the single power operational amplifier with N channel a-IGZO TFTs.

New Single Power OP-amp Circuit

Reference Circuit:

Proposed Circuit:

TFT	W/L	TFT	W/L
T1	40μm/10μm	T2	10μm/10μm
T3	40μm/10μm	T4	10μm/10μm
T5	40μm/10μm	T6	10μm/10μm
T7	40μm/10μm	T8	10μm/10μm
T9	40μm/10μm	T10	10μm/10μm
T11	40μm/10μm	T12	10μm/10μm
T13	40μm/10μm	T14	10μm/10μm
T15	40μm/10μm	T16	10μm/10μm
T17	40μm/10μm	T18	10μm/10μm
T19	40μm/10μm	T20	10μm/10μm
T21	40μm/10μm	T22	10μm/10μm
T23	40μm/10μm	T24	10μm/10μm
T25	40μm/10μm	T26	10μm/10μm
T27	40μm/10μm	T28	10μm/10μm
T29	40μm/10μm	T30	10μm/10μm
T31	40μm/10μm	T32	10μm/10μm
T33	40μm/10μm	T34	10μm/10μm
T35	40μm/10μm	T36	10μm/10μm
T37	40μm/10μm	T38	10μm/10μm
T39	40μm/10μm	T40	10μm/10μm
T41	40μm/10μm	T42	10μm/10μm
T43	40μm/10μm	T44	10μm/10μm
T45	40μm/10μm	T46	10μm/10μm
T47	40μm/10μm	T48	10μm/10μm
T49	40μm/10μm	T50	10μm/10μm
T51	40μm/10μm	T52	10μm/10μm
T53	40μm/10μm	T54	10μm/10μm
T55	40μm/10μm	T56	10μm/10μm
T57	40μm/10μm	T58	10μm/10μm
T59	40μm/10μm	T60	10μm/10μm
T61	40μm/10μm	T62	10μm/10μm
T63	40μm/10μm	T64	10μm/10μm
T65	40μm/10μm	T66	10μm/10μm
T67	40μm/10μm	T68	10μm/10μm
T69	40μm/10μm	T70	10μm/10μm
T71	40μm/10μm	T72	10μm/10μm
T73	40μm/10μm	T74	10μm/10μm
T75	40μm/10μm	T76	10μm/10μm
T77	40μm/10μm	T78	10μm/10μm
T79	40μm/10μm	T80	10μm/10μm
T81	40μm/10μm	T82	10μm/10μm
T83	40μm/10μm	T84	10μm/10μm
T85	40μm/10μm	T86	10μm/10μm
T87	40μm/10μm	T88	10μm/10μm
T89	40μm/10μm	T90	10μm/10μm
T91	40μm/10μm	T92	10μm/10μm
T93	40μm/10μm	T94	10μm/10μm
T95	40μm/10μm	T96	10μm/10μm
T97	40μm/10μm	T98	10μm/10μm
T99	40μm/10μm	T100	10μm/10μm

Mask Layout:

Microscope Image:

Simulation

Measurement:

Comparator Circuit Simulation:

Conclusion

- An analog electrical signals from sensors require the operational amplifiers to process the signal.
- In order to make a flexible or stretchable sensor devices, TFT-based operational amplifier is necessary.
- For the ADC, op-amp comparator is useful and implemented with a-IGZO TFTs.
- The developed single power op-amp comparators using the 20 a-IGZO TFTs were verified by simulation in AD, i.e., vector.
- The developed comparator can be used for converting the input analog voltage to the digital signal.

PRIM: 2016, October 3-7, in Honolulu, Hawaii

[H03-2166] Operational Amplifier Circuits with Oxide Thin Film Transistors

In Hye-Kang¹, Min-Tack Hong¹, Jong-Mo Lee¹, and Byung-Seong Ra²
¹Dept. of Display Engineering, Hoseo University, Asan, Chungnam 31499, Korea
 Tel: 82-41-546-5251; E-mail: hkyk@hoseo.edu
²Dept. of NanoBioTronics, Hoseo University, Asan, Chungnam 31499, Korea

Introduction

- The a-Si:H TFT is not suitable for an integrated circuit on a high resolution backbone due to the low charge carrier mobility. Oxide TFTs are replacing the a-Si:H TFTs because of low cost process, the higher mobility and lower leakage current than a-Si:H TFT. Since only the n-channel is available in an a-IGZO TFT, complementary circuit with both the N and P channel TFTs are not possible.
- One of the popular circuit is op-amp which can be used for the amplification of the analog signal or for the comparator. The measurements of sensing signal require an amplifier such as an op-amp and also comparators for the analog to digital converting. And also the circuits need a low-power consumption to enable a long use of the battery, and a small circuit area for the low cost and compact packaging. With above improvement of the technologies, one of the applications of TFT integrated circuits is inexpensive health diagnostics.
- Most of the analog circuit is adopting a CMOS-based op-amp for the excellent performance. TFTs can be used for the integrated circuits on the glass or the flexible substrate instead of attaching the chips on the substrate. For the sensing applications, we developed the single power operational amplifier with N channel a-IGZO TFTs.

New Single Power OP-amp Circuit

Reference Circuit:

Proposed Circuit:

TFT	W/L	TFT	W/L
T1	40μm/10μm	T2	10μm/10μm
T3	40μm/10μm	T4	10μm/10μm
T5	40μm/10μm	T6	10μm/10μm
T7	40μm/10μm	T8	10μm/10μm
T9	40μm/10μm	T10	10μm/10μm
T11	40μm/10μm	T12	10μm/10μm
T13	40μm/10μm	T14	10μm/10μm
T15	40μm/10μm	T16	10μm/10μm
T17	40μm/10μm	T18	10μm/10μm
T19	40μm/10μm	T20	10μm/10μm
T21	40μm/10μm	T22	10μm/10μm
T23	40μm/10μm	T24	10μm/10μm
T25	40μm/10μm	T26	10μm/10μm
T27	40μm/10μm	T28	10μm/10μm
T29	40μm/10μm	T30	10μm/10μm
T31	40μm/10μm	T32	10μm/10μm
T33	40μm/10μm	T34	10μm/10μm
T35	40μm/10μm	T36	10μm/10μm
T37	40μm/10μm	T38	10μm/10μm
T39	40μm/10μm	T40	10μm/10μm
T41	40μm/10μm	T42	10μm/10μm
T43	40μm/10μm	T44	10μm/10μm
T45	40μm/10μm	T46	10μm/10μm
T47	40μm/10μm	T48	10μm/10μm
T49	40μm/10μm	T50	10μm/10μm
T51	40μm/10μm	T52	10μm/10μm
T53	40μm/10μm	T54	10μm/10μm
T55	40μm/10μm	T56	10μm/10μm
T57	40μm/10μm	T58	10μm/10μm
T59	40μm/10μm	T60	10μm/10μm
T61	40μm/10μm	T62	10μm/10μm
T63	40μm/10μm	T64	10μm/10μm
T65	40μm/10μm	T66	10μm/10μm
T67	40μm/10μm	T68	10μm/10μm
T69	40μm/10μm	T70	10μm/10μm
T71	40μm/10μm	T72	10μm/10μm
T73	40μm/10μm	T74	10μm/10μm
T75	40μm/10μm	T76	10μm/10μm
T77	40μm/10μm	T78	10μm/10μm
T79	40μm/10μm	T80	10μm/10μm
T81	40μm/10μm	T82	10μm/10μm
T83	40μm/10μm	T84	10μm/10μm
T85	40μm/10μm	T86	10μm/10μm
T87	40μm/10μm	T88	10μm/10μm
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T93	40μm/10μm	T94	10μm/10μm
T95	40μm/10μm	T96	10μm/10μm
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Microscope Image:

Simulation

Measurement:

Comparator Circuit Simulation:

Conclusion

- An analog electrical signals from sensors require the operational amplifiers to process the signal.
- In order to make a flexible or stretchable sensor devices, TFT-based operational amplifier is necessary.
- For the ADC, op-amp comparator is useful and implemented with a-IGZO TFTs.
- The developed single power op-amp comparators using the 20 a-IGZO TFTs were verified by simulation in AD, i.e., vector.
- The developed comparator can be used for converting the input analog voltage to the digital signal.

PRIM: 2016, October 3-7, in Honolulu, Hawaii

[H03-2164] The Oxide TFT with Solution Based Gate Insulator

M.T. Hong¹, A.M. Lee¹, J.M. Park¹, E. Jeong¹, M. Mahmood-Braki¹ and B.S. Ra²
¹Laboratory of Electron Device, Hoseo University, Asan, Chungnam 316-795, Korea
 TEL: 82-41-546-5251; E-mail: hkyk@hoseo.edu
²TECH, Université De Rennes 1, Batiment 11B, Campus de Beaulieu, 35042 Rennes Cedex, France

Introduction

The electrical properties of TFTs are strongly influenced by gate insulator. Therefore, the gate insulator is a key factor for the electrical performance of the TFT. The a-Si:H TFTs are not suitable for an integrated circuit on a high resolution backbone due to the low charge carrier mobility. Oxide TFTs are replacing the a-Si:H TFTs because of low cost process, the higher mobility and lower leakage current than a-Si:H TFT. Since only the n-channel is available in an a-IGZO TFT, complementary circuit with both the N and P channel TFTs are not possible. One of the popular circuit is op-amp which can be used for the amplification of the analog signal or for the comparator. The measurements of sensing signal require an amplifier such as an op-amp and also comparators for the analog to digital converting. And also the circuits need a low-power consumption to enable a long use of the battery, and a small circuit area for the low cost and compact packaging. With above improvement of the technologies, one of the applications of TFT integrated circuits is inexpensive health diagnostics. Most of the analog circuit is adopting a CMOS-based op-amp for the excellent performance. TFTs can be used for the integrated circuits on the glass or the flexible substrate instead of attaching the chips on the substrate. For the sensing applications, we developed the single power operational amplifier with N channel a-IGZO TFTs.

Experiment

Figure 1: Schematic diagram of the experimental setup for the fabrication of the oxide TFT with solution based gate insulator. The process includes Spin Coating, Exposure, and Hard-Bake.

Figure 2: Microscopic image of the oxide TFT with solution based gate insulator.

Results

Properties of SU-8 vs Exposure Time:

TFT Characteristics:

References and Acknowledgments

References: [1] M. T. Hong, A. M. Lee, J. M. Park, E. Jeong, M. Mahmood-Braki, and B. S. Ra, "The oxide TFT with solution based gate insulator," *PRIM: 2016, October 3-7, in Honolulu, Hawaii*, pp. 2016-2017, 2016.

Acknowledgments: This work was supported by the National Natural Science Foundation of China (Grant No. 61474102) and the National Natural Science Foundation of China (Grant No. 61474102).

[H03-2162] Amplifier Circuit with Oxide Thin Film Transistor

Y. L. Han¹, J. H. Kang², Y. E. Jeon³, Y. J. Lee¹ and B. S. Bae^{1*}
¹ Department of Display Engineering, Hoso University, Asan, Chungnam 31499, Korea
² Tel. 82-41-540-5221, E-mail: hbae@hoso.edu
³ Department of NanoBioTechno, Hoso University, Asan, Chungnam 31499, Korea

Abstract
 Oxide TFT (thin film transistor) has higher electron mobility and less leakage current than amorphous silicon TFT and the IGZO TFT has been studied by many researchers and used in the display backplane. In this work, an amplifier circuit with oxide TFTs is presented. The voltage gains of 10 was obtained with two cascade class A amplifier, and it operates well for the threshold voltage change from -2V to 3V.

Introduction

- For portable audio amplifier, low power and compact design are necessary. For the compact and flexible devices, fully integrated circuit on a substrate is necessary. Among the possible devices for integrated circuits, thin film transistor with oxide semiconductor material is one of the candidates due to its higher field effect mobility. The audio amplifier with oxide TFT was investigated and optimized for the outputs without distortion.
- Most commonly used type of power amplifier is the class A amplifier. The class A amplifier is the most common and simplest form of power amplifier, in which transistor is always on state so that it conducts during one complete cycle of the input signal waveform producing minimum distortion and maximum amplitude to the output. The efficiency of this type of circuit is low and it delivers small power outputs.
- To get high amplification gain, we designed a common source amplifier in which TFT was used as a load resistance. In the inverter, the gate is connected to drain electrode, for the load resistance. The DC operating voltage for the input gate electrode is also important, and the conventional way to get the operation voltage is using resistor divider, in which we should design the resistor divider according to the characteristics of TFT.

Amplifier Circuit with Inverter

For the Linearity and High Gain

Simulation

TFT Characteristics

Conclusion

PHOME 2016 PACIFIC RIM MEETING on electrochemical and solid-state science, October 2-7, 2016

[H03-2158] GaN based Ethanol Sensor

Saewon Jung¹, Kwang Hyon Baik², Seung Jai Baek¹, Soohwan Jung¹
¹ Department of Chemical Engineering, Dankook University, Yongsu, 16896, Republic of Korea
² Department of Materials Science and Engineering, Hangeul University, Seohyun, 28115, Republic of Korea
³ Department of Mechanical Engineering, Dankook University, Yongsu, 16896, Republic of Korea

Introduction

Device Structure

Characteristics

Conclusion

PHOME 2016 PACIFIC RIM MEETING on electrochemical and solid-state science, October 2-7, 2016

[H03-2161] Oxide TFT with SOG Gate Insulator

S. H. Hwang¹, M. T. Hong¹, J. M. Lee¹, H. J. Jang¹, E. J. Yun¹, H. S. Huh¹, M. S. Kim¹ and B. S. Bae^{1*}
¹ Dept. of Display Engineering, Hoso University, Asan, Chungnam 31499, Korea
² Dept. of Electronic Research Laboratory, Nepean Institute of Science & Technology, Cheongju-si Chungbuk 387-32, Korea

Abstract
 We investigated solution processed gate insulator for the top gate oxide TFT. The solution process does not require the use of expensive vacuum equipment, and also has advantages of simple process, high productivity and low cost. The methyl siloxane based spin-on-glass was investigated for the gate insulator, buffer layer and passivation layer. The top gate amorphous indium-gallium-zinc-oxide (a-IGZO) oxide TFT was optimized to get the mobility of 5.48cm²/Vs.

Introduction

Experimental

Results and Discussion

Conclusion

PHOME 2016 PACIFIC RIM MEETING on electrochemical and solid-state science, October 2-7, 2016

[H03-2160] Rectification Properties of Boron Nitride/Silicon Heterostructure Diodes

K. Terai¹, H. Ito¹, N. Katayama¹, S. Matsumoto^{1,2}
¹ Osaka University, Kasuga, Fukuoka 816-8580, Japan
² National Institute for Materials Science, Tsukuba, Ibaraki 305-8565, Japan

Outline

Rectification characteristics and Frenkel-Poole plots

Band diagrams of the p-cBN/sp³BN/n-Si heterojunction

RESULTS AND DISCUSSION

Electrical contacts of Ni to sp³BN and cBN films

Acknowledgements

PHOME 2016 PACIFIC RIM MEETING on electrochemical and solid-state science, October 2-7, 2016

Conclusions

SOFCs

A solid oxide fuel cell has been built in STAR-CCM+ utilizing the electrochemical reaction and reaction heating model. In the current version 11.02, component fluxes and linearization must be specified manually. Six month goals are to replace them with the ability to electrochemically react multi-component gas species. The electrochemical reaction model has been confirmed to conserve electric current at the cathode collectors and across the triple phase boundaries. Species mass conservation is confirmed by comparing specified reaction fluxes to component flows at inlets and outlets. Finally, the electrochemical reaction heating model based on temperature dependent electrode potentials is calculated based on formation enthalpy data from NIST thermodynamic tables and the model is shown to be conservative when incorporating joule heating.

Electrochemical Reactions produce species (6 mo.)

Phasic Porous Media (6 mo.)

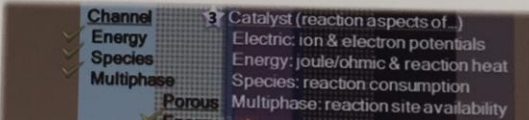
- Distinguish solid and fluid variables
- Phasic Temperatures, Electric Potentials, etc.
- Volume Averaged Electrochemical Reactions (planned)
- Anisotropic area porosity, tortuosity analog?

Volume Porosity
 $V' = \gamma V$
 Area Porosity Tensor
 $A' = K \cdot A$
 Transport Equation

$$\frac{\partial}{\partial t} \int \rho Y_i dV' + \oint \rho Y_i v \cdot dA' - \oint J_i \cdot dA' = \int S_i dV'$$

EMFCs

- 1) Multiphase in porous media
- 2) Hydrated membrane transport
- 3) Porous electrode reactions



Abstract
 Characteristics of Sr_{0.9}Y_{0.1}XTi_{1-x}Y_{0.3-3x} anode in humidified methane fuel for solid oxide fuel cells
 Eun gyung Park, Jeong Woo Yun
 *Chonnam National University (eeyun@knu.ac.kr)

Introduction
 Mechanism of solid oxide fuel cells

Advantage
 Solid oxide fuel cells (SOFCs) are a promising alternative energy conversion device because of high energy efficiency and fuel flexibility.

Disadvantage
 SOFCs are operated at high temperature (800-1000 °C). The high temperature is a disadvantage because of high thermal expansion coefficient and low thermal conductivity. The SOFCs are operated at high temperature (800-1000 °C) and have low thermal conductivity. The SOFCs are operated at high temperature (800-1000 °C) and have low thermal conductivity.

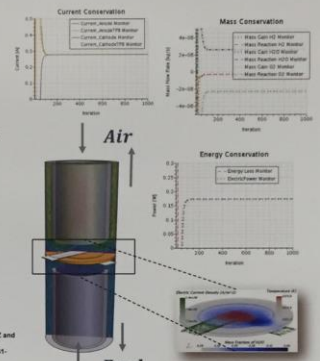
Experimental
 Synthesis of the anode, Fabrication of cell components, Measurement of cell performance.

Result and discussion
 The SOFCs were operated at 800 °C in humidified methane fuel. The SOFCs were operated at 800 °C in humidified methane fuel. The SOFCs were operated at 800 °C in humidified methane fuel.

Conclusion
 The SOFCs were operated at 800 °C in humidified methane fuel. The SOFCs were operated at 800 °C in humidified methane fuel. The SOFCs were operated at 800 °C in humidified methane fuel.

MDX Data Fitting

- 6K cell prototype
- Current (electrode = tab collector)
 - Mass (in - out = reaction)
 - Energy (in - out = power)
- Steady State in 150-500 iterations
- Runs one minute (1 core)
 - Tune exchange current



Energy/Voltage Losses

Maximum: Enthalpy consumed by reaction*

$$V_{max} = \int \sum v_i M_i \bar{h}_i^{ref} \frac{1}{nF} \cdot dA \int j \cdot dA$$

Available: Gibbs Energy*

$$V_{free} = \int \sum v_i M_i (\bar{h}_i^{ref} - T \bar{s}_i^{ref}) \frac{1}{nF} \cdot dA \int j \cdot dA$$

Losses:

- Ohmic

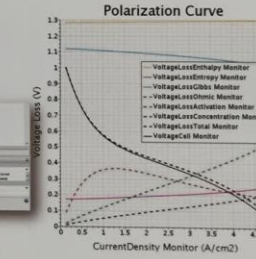
$$V_{ohm} = \int \frac{j \cdot dA}{\sigma} \int j \cdot dA$$

- Activation

$$V_{act} = \int \eta \cdot dA \int j \cdot dA$$

- Concentration (Mixture Entropy)*

$$V_{conc} = \int \frac{RT}{nF} \sum v_i \ln \left(\frac{c_i}{c_i^{ref}} \right) j \cdot dA \int j \cdot dA$$



Cell Stack

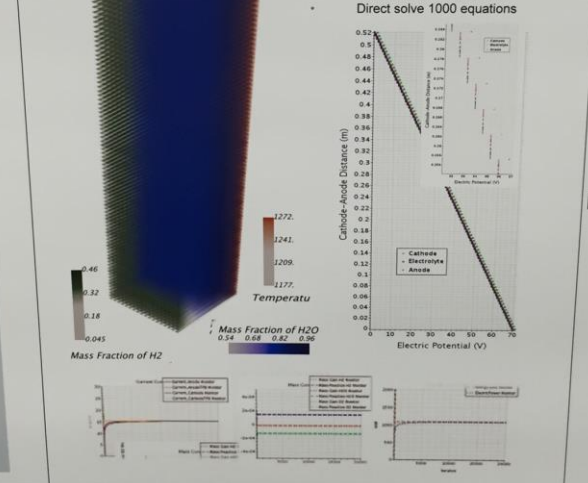
$$V_{conc} = \int \frac{RT}{nF} \sum v_i \ln \left(\frac{c_i}{c_i^{ref}} \right) j \cdot dA \int j \cdot dA$$

Concentration (Mixture Entropy)*

100 stack: 3M cells 10K iterations
 10 hours 48 core
 Room for improvement!

Electric Potential hardest to converge

- Needs Good Initial Guess
- Direct solve 1000 equations



SOFCs

A solid oxide model has been built in STAR-CCM+ utilizing the electrochemical reaction and reaction heating model. In the current version 11.02, component fluxes and linearization must be specified manually. Six month goals are to replace them with the ability to electrochemically react multi-component gas species. The electrochemical reaction model has been confirmed to conserve electric current at the cathode collectors and across the triple phase boundaries. Species mass conservation is confirmed by comparing specified reaction fluxes to component flows at inlets and outlets. Finally, the electrochemical reaction heating model based on temperature dependent electrode potentials is calculated based on formation enthalpy data from NIST thermodynamic tables and the model is shown to be conservative when incorporating joule heating.

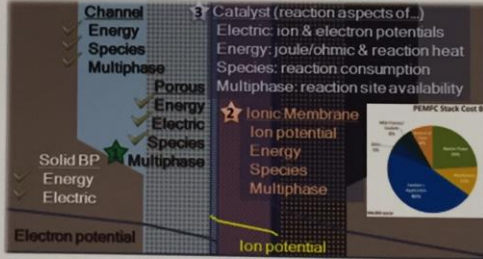
- Electrochemical Reactions produce species (6 mo.)
- Phasic Porous Media (6 mo.)
 - Distinguish solid and fluid variables
 - Phasic Temperatures, Electric Potentials, etc.
- Volume Averaged Electrochemical Reactions (planned)
- Anisotropic area porosity, tortuosity analog?

- Volume Porosity $V' = \gamma V$
- Area Porosity Tensor $A' = K \cdot A$
- Transport Equation

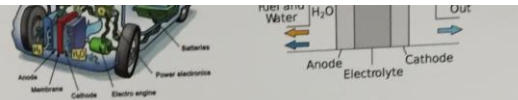
$$\frac{\partial}{\partial t} \int \rho Y_i dV' + \oint \rho Y_i v \cdot dA' - \oint J_i \cdot dA' = \int S_i dV'$$

PEMFCs

- Multiphase in porous media
- Hydrated membrane transport
- Porous electrode reactions

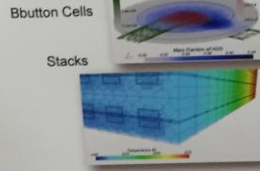


Multiphase



Simulation Procedure

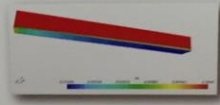
- 3D-CAD to Mesh pipeline
- Multiple Physics Continua
- Reporting Results
- Automation Scripts



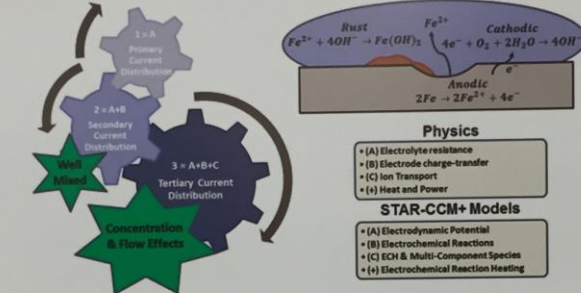
Physics Models

- Segregated Flow, Energy, Species & Electrodynamic Potential
- ECH Reactions (electric potential only)
- Species Consumption using Flux Linearization by Field Function*
 - Nonlinear implicit interface conditions
 - More robust than boundary cell sources

Surface Reaction Analog



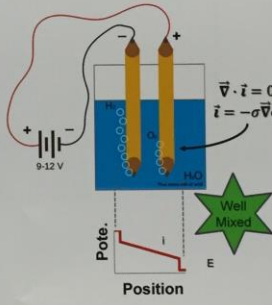
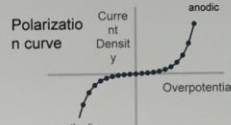
*Release Multicomponent Electrochemical Reactions (3-6 mo.)	amplitude	0.1	0.1	0.1	1	1
Equilibrium Potential from gas thermodynamic data by Field Function*	slope	0.1	1	10	1	10
	Iterations (old)	200	750	1050	6500	0
	Iterations (new)	200	200	200	200	200



Current Distribution (2nd)

- Electrolyte Conduction

- Electrode Reactions
 - Electrochemical Reactions Model
 - Tabular polarization curve, Butler-Volmer, Tafel, Transfer-limited Tafel,...
 - Equilibrium Potential
 - Exchange Current Density



Electrochemical Energy

The thermodynamics of electrochemical reactions has been outlined in previous publications by the same name [3]. By linear fitting free energy thermodynamic data from NIST-JANAF tables, previous authors have computed the standard electrode potential for the combined reaction is a linear function of temperature [2]. This assumes constant enthalpy and entropy for the combined anodic-cathodic reaction over the range 900-1200 C.

$$H_2(g) + \frac{1}{2} O_2(g) \leftrightarrow H_2O(g) \quad 1$$

The resultant combined cell potential is

$$E_{comb}^0 \approx 1.28 - 0.000284 \cdot T \quad 2$$

This linear relationship is NOT used in the current prototype, as higher-order polynomial thermodynamic data is available and we are separating anode and cathode reactions. We begin by recalling our "reduction current" convention, where reduction is gain of the reactant electron,

$$ne^- = \sum_i \nu_i A_i \quad 3$$

The heat release is the product of the reaction enthalpy, ΔH_R , and the molar reaction rate, $\frac{1}{nF}$,

$$Q_R = -\frac{\Delta H_R}{nF} \quad 4$$

The reaction enthalpy may be related to the formation enthalpies of the reactants and products. Because these are electrochemical reactions, the formation enthalpies have chemical and electrical components.

$$\Delta H_R = \sum_i \nu_i (\Delta H_{f,i}^0 + z_i F \phi) \quad 5$$

Since the electron has charge of -1, all ions exist in the electrolyte phase, and the reaction is electroneutral

$$\Delta H_R = \Delta H_R^0 + nF(\phi_{electron} - \phi_{ion}) ; \Delta H_R^0 = \sum_i \nu_i \Delta H_{f,i}^0 \quad 6$$

As the oxide ion in the electrolyte membrane is not being modeled explicitly in STAR-CCM+, we have no access to a value for its formation enthalpy. The assumption made here is that the formation enthalpy of oxide ion in the electrolyte phase is always zero.

As the reaction progresses from reactants to products by one molar extent, ξ , the Gibbs free energy of reaction may be related to the electrochemical potential of the reactants and products.

$$\Delta G_R = \frac{\partial G}{\partial \xi} = \sum_i \nu_i \mu_i \quad 7$$

The electrochemical potential is a function of the species activity, a_i , and its Gibbs free energy of formation.

$$\mu_i = \frac{\partial G}{\partial N_i} = \Delta G_{f,i}^0 + RT \ln(a_i) + z_i F \phi \quad 8$$

By substitution and recalling previous electro-neutrality arguments

$$\Delta G_R = \Delta G_R^0 + RT \sum_i \nu_i \ln(a_i) + nF(\phi_{electron} - \phi_{ion}) ; \Delta G_R^0 = \sum_i \nu_i \Delta G_{f,i}^0 \quad 9$$

At equilibrium, the Gibbs free energy of reaction will be zero and we can derive the Nernst equation for the equilibrium potential of the reduction reaction, E_{eq}^{red} .

$$E_{eq}^{red} = (\phi_e - \phi_{ion})_{eq} = E_{eq}^{red} = \frac{RT}{nF} \sum_i \nu_i \ln(a_i) ; E_{eq}^{red} = -\frac{\Delta G_R^0}{nF} \quad 10$$

1. BIBLIOGRAPHY
 [2] F. Schull, "Thermodynamics of electrochemical reactions," Electrochemical Methods, Springer Berlin Heidelberg, pp. 10-11, 2005.
 [3] A. D. S. B. A. J. S. P. M., "Validation of a Solid Oxide Fuel Cell Model,"

Electrochemistry Modeling for Energy Conversion and Storage

Dr. C. Lueth, Dr. C. Walchshofer, Dr. V. Palanisamy

SIEMENS
Ingenuity for life

Description	Theory	Results	Conclusions
<p>Electrochemistry Application</p> <ul style="list-style-type: none"> Electrochemical Energy Storage Electrochemical Energy Conversion Electrochemical Energy Production <p>Fuel Cells & Electrolyzers</p> <ul style="list-style-type: none"> Proton Exchange Membrane (PEM) Solid Oxide (SOFC) <p>Simulation Procedure</p> <ul style="list-style-type: none"> 3D-CAD to Mesh pipeline Multiple Physics Continua Reordering Results <p>Physics Models</p> <ul style="list-style-type: none"> Electrochemistry Fluid Flow Thermodynamics Reaction Kinetics 	<p>Electrochemistry</p> <ul style="list-style-type: none"> Current Distribution (2D) Electrochemical Energy <p>MOX Data Fitting</p> <ul style="list-style-type: none"> SOFCs PEMFCs <p>Cell Stack</p> <ul style="list-style-type: none"> Membrane Models? 	<p>SOFCs</p> <ul style="list-style-type: none"> Energy/Voltage Losses PEMFCs <p>Cell Stack</p> <ul style="list-style-type: none"> Membrane Models? 	<p>Conclusions</p> <ul style="list-style-type: none"> Optimal Performance Water management, fouling

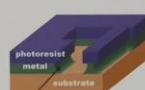

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Flow Batteries

Ionic Wind / Plasmas

Multiphysics

- Mass, Energy, Charge transfer
- Reaction Kinetics
- Thermodynamics

Fuel Cells & Electrolyzers

Electrochemically convert chemical energy of **FUEL to ELECTRICITY**

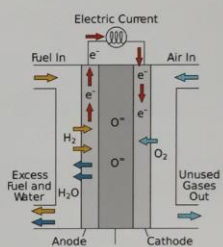
- Full Stacks
- Optimal Performance

Proton Exchange Membrane (PEM)

- Low Temperature (60-80 C)
- Water management, fouling

Solid Oxide (1000K & O²⁻)

- High Temperature



Simulation Procedure

3D-CAD to Mesh pipeline
Multiple Physics Continua
Reordering Results

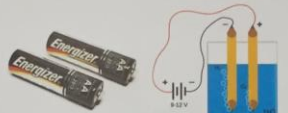

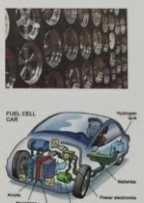
Description

Electrochemistry Application

- Batteries
- Corrosion
- Electrolysis
- Electroplating
- Fuel Cells
- Flow Batteries
- Ionic Wind / Plasmas

Multiphysics

- Mass, Energy, Charge transfer
- Reaction Kinetics
- Thermodynamics

Fuel Cells & Electrolyzers

Electrochemically convert chemical energy of **FUEL to ELECTRICITY**

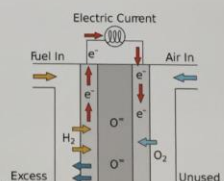
- Full Stacks
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Proton Exchange Membrane (PEM)

- Low Temperature (60-80 C)
- Water management, fouling

Solid Oxide (1000K & O²⁻)

- High Temperature



Enhanced Thermoelectric Properties in One-Dimensional Mg/Ge Nanostructures

(Z02-4151)
*Hsiueh-Chang Lin, *Ming-Xun Jiang, *Cheng-Lin Hsin, *Jung-Kuei Chang, *Sheng-Wei Lee
*Institute of Materials Science and Engineering, National Central University, Chung-Li 32001, Taiwan
*Institute of Electrical Engineering, National Central University, Chung-Li 32001, Taiwan

Introduction

Techniques for converting waste heat into useful electricity have become an important research topic in recent years. For this purpose, thermoelectric (TE) materials which can generate electricity while under a temperature gradient as power generation and cool down the heat have attracted much attention. Recently, it is believed that Mg₂X (where X can be Ge, Sn, Se or Te) based compounds are collectively and co-tolerably candidates for future large-scale commercial systems in mid-temperature. Mg₂X compounds exhibit a favorable combination of physical and chemical properties and are highlighted as a promising thermoelectric material. This work fabricated one-dimensional nanostructures assisted by electrochemical method and measured thermoelectric properties.

Experimental Procedures

1. Property measurement

2. Fabrication

3. Characterization

4. Results and discussion


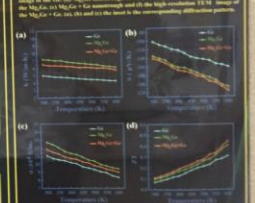
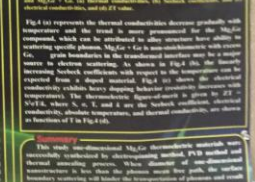




Fig. 1 TEM images of the one-dimensional Mg/Ge and Mg/Te nanostructures with the high-resolution TEM images of the Mg/Ge (a) and Mg/Te (b) nanostructures and the high-resolution TEM images of the Mg/Ge (c) and Mg/Te (d) nanostructures and the corresponding diffraction patterns.

Fig. 2 Temperature-dependent thermoelectric properties of the Mg/Ge and Mg/Te (a) and Mg/Te (b) nanostructures. The Seebeck coefficient and the electrical conductivity are shown as a function of T in Fig. 2(a) and (b).

Fig. 3 The Seebeck coefficient and the electrical conductivity of the Mg/Ge and Mg/Te nanostructures as a function of T in Fig. 3(a) and (b).

Fig. 4 The Seebeck coefficient and the electrical conductivity of the Mg/Ge and Mg/Te nanostructures as a function of T in Fig. 4(a) and (b).

Fig. 5 The Seebeck coefficient and the electrical conductivity of the Mg/Ge and Mg/Te nanostructures as a function of T in Fig. 5(a) and (b).

Formation and Characterization of a Well-Packed Particulate Structure Consisted of Cu NPs by Capillary Force for Low Resistivity at Low Temperature

Blue "Magnum", North Chungshing University, Taiwan, and Hsinchu National University of Education, Taiwan

Introduction and Objective

Our previous work about Cu NPs... Objective: The present work is to study the formation of well-packed particulate structure by capillary force at low temperature and low resistivity Cu NPs.

Experimental

Selection of an optimal solvent to use capillary force effectively

Solvent Type	Apparent Density (g/cm ³)	Resistivity (μΩ/cm)
Water	1.00	20.1
Alcohol	0.79	20.1
Acetone	0.79	20.1
Hexane	0.66	20.1
Oil	0.92	20.1

Results and Discussion

Effect of Cu NP size on the closely packed Cu NP films for lower resistivity

Conclusions

The present work is to study the formation of well-packed particulate structure by capillary force at low temperature and low resistivity Cu NPs.

230th ECS Z02-4148

Growth Mechanism of Silver Nanowires by Polyol Process and Their Application for Transparent Conductive Thin Film

H. F. Hsu, L. Z. Hong, C. F. Lin, and C. H. Lu
Department of Materials Science and Engineering, National Chung Hsing University, Taichung 402, Taiwan, R.O.C.
E-mail: hhsu@dragon.nchu.edu.tw

Polyol process, one of widely used method for Ag NWs chemical synthesis, could be used to produce Ag NWs by adding Cl⁻ ions with appropriate concentration in the process. Besides Ag NWs, Ag particles could also be formed with addition of much higher or lower Cl⁻ ions. In this study, optimal reaction time and concentration of Cl⁻ ions for Ag NWs synthesis have rarely been reported. The results show that Ag nanoparticles were initially formed and gradually turned into nanowires because of polyvinylpyrrolidone (PVP) addition. However, Ag NWs would gradually shorten while growing at critical length in the reaction. This interesting phenomenon could be explained by the reducing of surface energy. Furthermore, the longest Ag NWs have better condition of optimal reaction time and concentration of Cl⁻ ions. Transparent conductive thin films with long Ag NWs have better conductivity than short ones, and their stability would be further increased while coating the Poly(methylmethacrylate) (PMMA) as protective layer.

Experimental

The effect of NaCl concentration on Ag NW growth

Ag nanoparticles were initially formed then Ag NWs would gradually grow in the reaction. The length of Ag NWs would be further increased while coating the PMMA as protective layer.

Application on the transparent conductive thin film

The present work is to study the formation of well-packed particulate structure by capillary force at low temperature and low resistivity Cu NPs.

Development of effective extraction process of insoluble Sb species in urban mine and the metal complexes condition - Relationship between the local structure of Sb in urban mine and the condition of Sb complexes in Sb-tartronic acid-OH aqueous system -

Mitsuru Takahashi, Shinya Imai, Shun Yokoyama, Kenyoshi Taji
Graduate School of Environmental Studies, Tohoku University, 1-1-1, Aramaki, Aoba, Aoba-ku, Sendai, 980-8578, Japan
E-mail: takahashi@es.tohoku.ac.jp

Background

It is well known that urban mine has accumulated as "urban mine" without utilization. Among these urban mine, a part of antimony (Sb) cannot be recycled because of its toxicity and insolubility. Therefore, Sb-rich slag, one of remaining products, includes about 10 wt% of antimony (Sb). On the other hand, we reported the new condition of well-crystallized and uniform alloy nanoparticles by controlling the homogeneous of metallic complex in the aqueous solution. In this study, metal complex condition is calculated by using critical stability constants as a function of solution pH.

Our technique for the preparation of homogeneous alloy nanoparticles

Metal Complex Extraction method? → Synthesis method → Solid material

Objective

In this study, relationship between the condition of Sb in insoluble urban mine and metal complexes condition in aqueous solution was evaluated.

Results and Discussion

Results of calculation indicated that complex species change from SbCl₄⁻ complex species to SbCl₃ complex species in the Sb-Cl-OH system at around pH 1. This result suggests that Sb distribution system is dominantly changed at around this pH range. Therefore, we determined a dissolution rate of Sb in Cl⁻ by the addition of Cl⁻ in aqueous solution. XRF data showed that dissolved amount of Sb became maximum value in pH 2-3, which showed good correspondence with the calculation result. The XRF data showed that dissolved amount of Sb in the solution was maximum value with charge of 1-, rather than the formation of Sb(OH)₃ complex identified by EXAFS data equally constant of 10²¹ mol. Sb in the solution was maximum value with charge of 1-, rather than the formation of Sb(OH)₃ complex identified by EXAFS data equally constant of 10²¹ mol. Sb in the solution was maximum value with charge of 1-, rather than the formation of Sb(OH)₃ complex identified by EXAFS data equally constant of 10²¹ mol.

Conclusions

Dissolution ratio of Sb reached to 30% (1500ppm) of Sb in the slag at pH 2.1. This calculation method will provide accurate analysis of rare metals in urban mine.

A Comparative Study of Anodic Aluminum Oxide Preparation for Synthesis of Nanomaterials

Amnisha Brajda^{1,2}, Anna Brudnia¹, Grzegorz D. Sulka²
¹ - Poznan University of Technology, Poland, Poland
² - Jagiellonian University in Krakow, Krakow, Poland
e-mail: brajda@chemia.uj.edu.pl

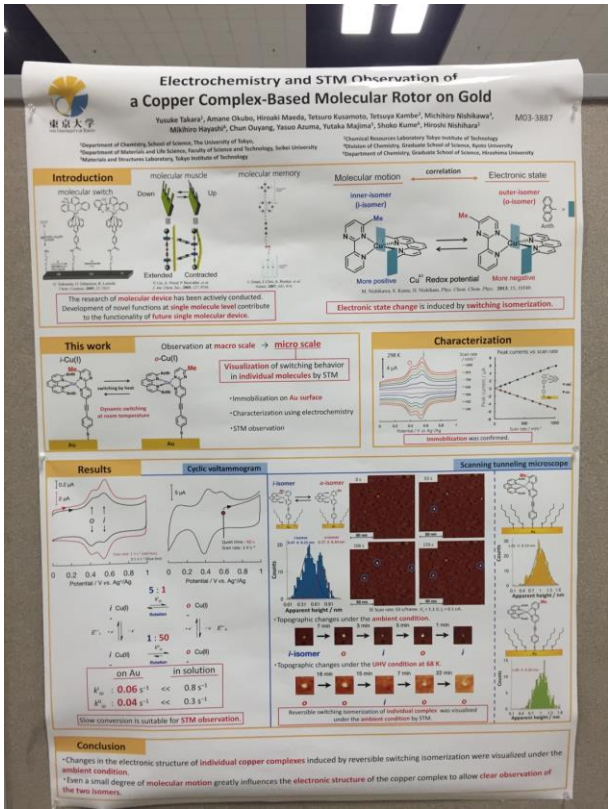
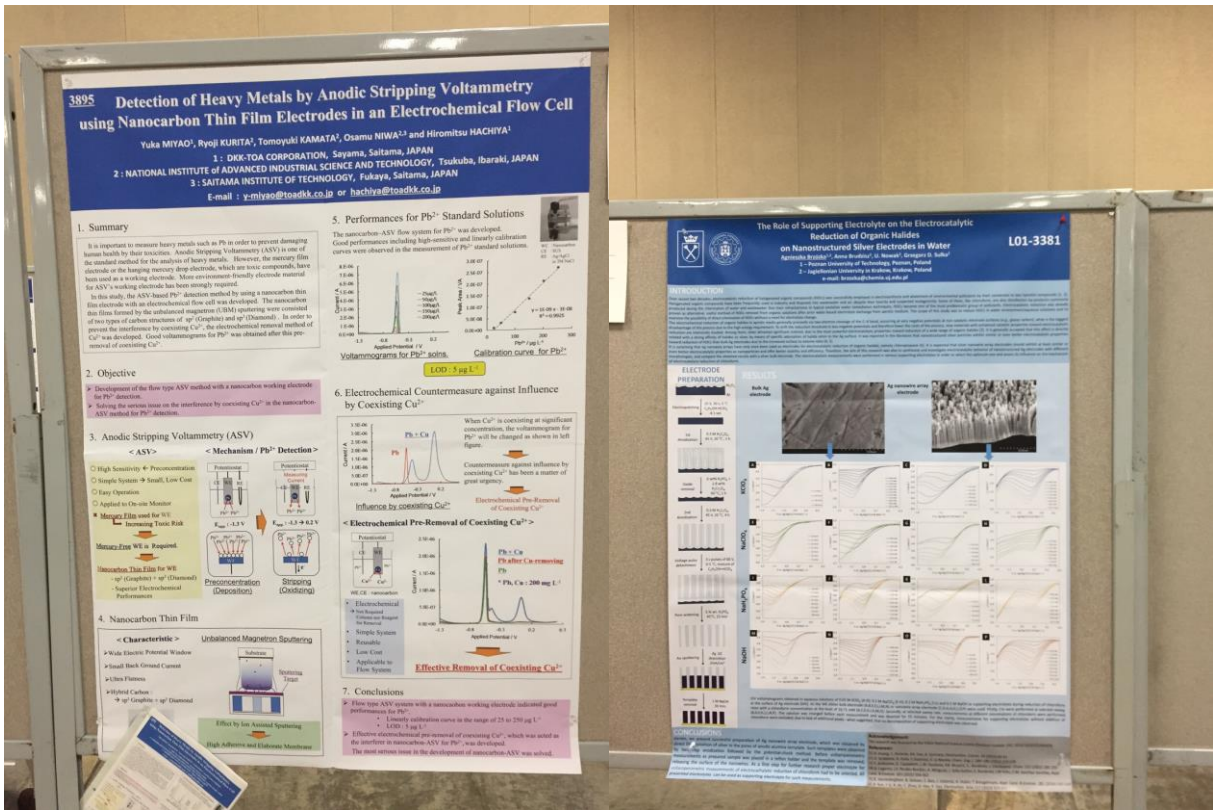
INTRODUCTION

Anodized barrier layers of aluminum oxide is one of the most simple and fastest fabricating way. The barrier layer formed during anodization process can be prepared by a facile anodization of Al in H₂SO₄ solution, which is not suitable to carry out electrochromic thin films. Due to the presence of the non-conductive oxide barrier layer of the electrolyte solution, which is not suitable to carry out electrochromic thin films. Due to the presence of the non-conductive oxide barrier layer of the electrolyte solution, which is not suitable to carry out electrochromic thin films. Due to the presence of the non-conductive oxide barrier layer of the electrolyte solution, which is not suitable to carry out electrochromic thin films.

EXPERIMENTAL & RESULTS

Barrier layer thinning, Voltage pulse detachment

The present work is to study the formation of well-packed particulate structure by capillary force at low temperature and low resistivity Cu NPs.



The Effect of Thermal Hydrogenation Processing on the Nano-Size Grain Refinement and Oxide Layer Formation of Ti-6Al-4V Alloy

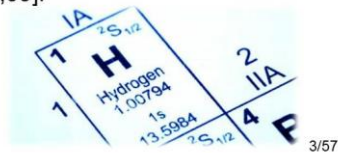
L. M. Wang, C. J. Tsai



Chung Cheng Institute of Technology,
Dept. of Power Vehicle and System Engineering
University of National Defense, Taiwan, R.O.C.

2. Recently, extensive studies have been reported on **refinement of the grain size** of titanium alloys using a **thermo-hydrogenation process (THP)** by employing **hydrogen** as a **temporary alloying element**.

*THP, by using :
hydrogenation and **dehydrogenation process**
[Yu,06;She,07;She,09].



8. **Control of O₂ flowing rate into the furnace** containing THP processed sample of **Ti-6-4 alloy** may be possible to **control** the desirable **thickness** and **composition** of Ti-6-4 and therefore :
improve the corrosion resistance of T-6-4 alloy.



However, in the literature:

- It is noted that the employed temperature for THP is mostly among the range of 650-850 °C with the amount of hydrogenation mostly lower than 0.4 H/M (the mole ratio of hydrogen to the alloy atoms of related alloy)
[Sun,09 ; Sha,07; Sha,08 ; Liu,09 ; Zhu,09 ; Zha,10; Zha,08;Sun,09; Li,07; Zon,07]

Introduction

1. **Ti-6-4 alloy** is a promising material.

Major applications are in :

- aerospace,
 - automobile,
 - military industries
- because of its :
- low density,
 - excellent mechanical,
 - corrosion properties

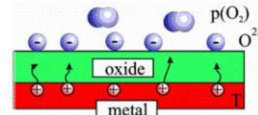


5. THP can produce **nano grains**.

[Yu,06;She,07;She,09].

6. **Oxide layer** produced on nano grains may be a good way to enhance the **corrosion resistance** of Ti-6-4 alloy.

7. There are **limited reports** on the **corrosion behavior** of **grain-refined** Ti alloys resulting from the THP.



The thickness of oxide layer and its corrosion resistance (I_{corr}) vs. Earlier works in Literature from related treatments

References/ present work	Treatment Process	Electrolyte Solution	Thickness of Oxide Layer (μm)	I_{corr} (A/cm ²)
Kumar et al. ^[20]	CP-Ti + heat-treatment (850 °C, 8~48 h)	Ringer's solution	3.5~19	4.2×10^{-7} ~ 6.7×10^{-6}
Kumar et al. ^[21]	CP-Ti + heat-treatment (500~800 °C/24 h)	Ringer's solution	~30	2.9×10^{-7} ~ 2.2×10^{-5}
Kumar et al. ^[22]	Ti-6Al-4V + heat-treatment (500~800 °C, 8~48 h)	Ringer's solution	7~79	1.3×10^{-6} ~ 2.8×10^{-7}
present work	Ti-6Al-4V + BST + THP	H ₂ SO ₄	0.56	2.78×10^{-10}
Present work	Ti-6Al-4V + BST + THP + ANNO ₂ (750 °C/2 h + 5% sodium oxalate)	H ₂ SO ₄	1.04	8.39×10^{-11}

Wang et al. , J. ECS, 160,(11) C560-C568(2013)

- Yu [Yu,06] and Shen [She,14;She,09] studied THP at 600 °C with hydrogenation loading at the ranges 0.1-0.9 H/M and reported with disagreements in hydride formation and microstructure evolution with above reports.

•Although the grain refinement in THP process was found as early as in 1979 by Mahajan et al. [Mah,79], the possible mechanism was not explained until in 2009 by Shen et al.[She,09] on the loading of 0.7 H/M at 600 °C in THP process, in which phase transformation was proposed as the main reason for the grain refinement.

• In 2010 Zhao et al.[Zha, 10] confirmed the phase transformation leading to the grain refinement and further proposed that the recrystallization may result in the grain refinement when studied THP with hydrogenation loading at 0.1-0.4 H/M at 750 °C and dehydrogenation at 700 °C.

• Shen et al. [she, 14]proposed that during hydrogenation process, the precipitation of the hydride of β_H and δ phase leads to the defects in the matrix and these defects would be the main routes to cause the grain refinement.

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•However, based on the phase diagram not in agreement and microstructure from SEM only possibly makes the uncertainty remained; as far as the defect is concerned, the lack of the atomic size scale evidence may lead to the different arguments.

•Thus, the phase diagram, microstructure evolution, the influence of produced defects to the grain refinement still need further studied to build up its more accurate features during THP process.

• The aim of this study is to add more understanding of the defect produced during THP process in terms of microstructure evolution leading to grain refinement with hydrogenation loading at 0.1-0.7 H/M at 600 °C and dehydrogenation at 600 °C.



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Experimental work

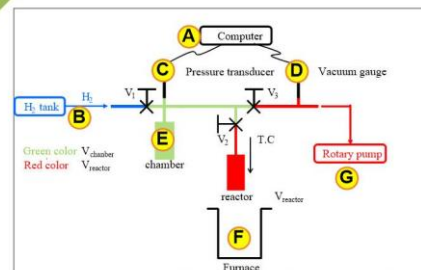
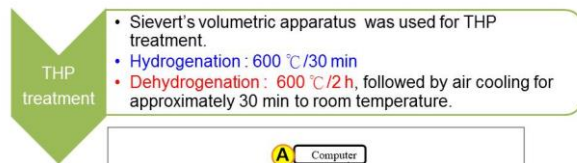
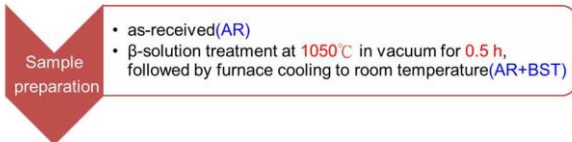


Fig.1 Sievert's volumetric apparatus diagram

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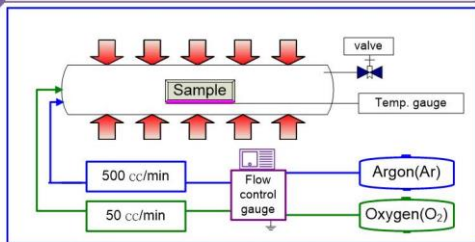
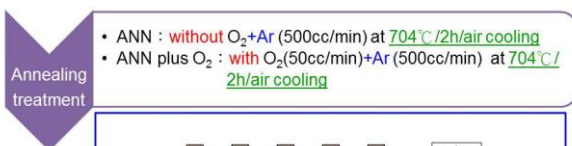


Fig.2 Annealing treatment diagram

All the samples were ground with SiC abrasive papers and further polished with fine grade diamond paste before each stage treatment.

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Result and Discussion

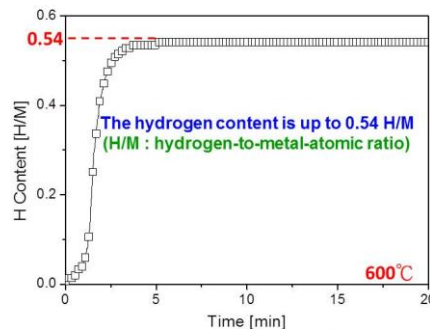


Fig.3 Typical kinetic curves for hydrogen absorption

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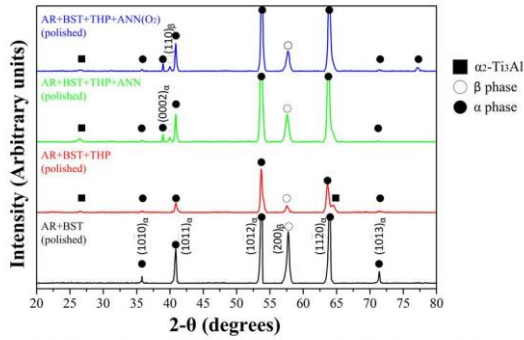


Fig.4 XRD patterns of Ti-6-4 alloy after related treatments. The identified phases of α , α_2 , and β are marked.

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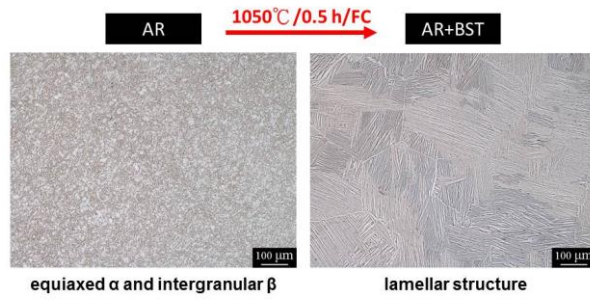


Fig.5 Optical micrographs of β -solution treated Ti-6-4 alloy

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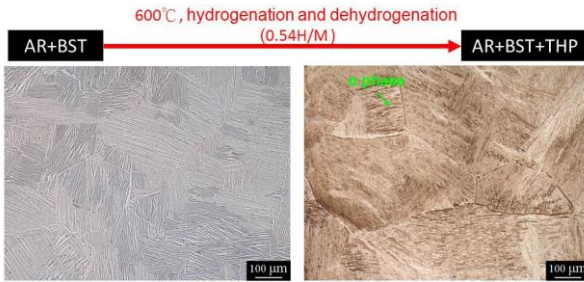


Fig.6 Optical micrographs of Ti-6-4 alloy subjected to THP treatment at 600°C following β -solution treatment the lamellar structure is preserved associated with severely etched feature after THP treatment

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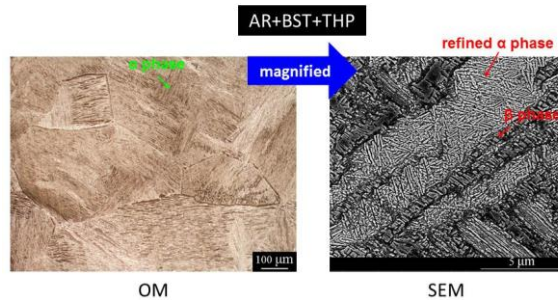


Fig.7 Optical and SEM micrographs of Ti-6-4 alloy subjected to THP treatment at 600°C grain refinement within the α matrix is observed through SEM technique

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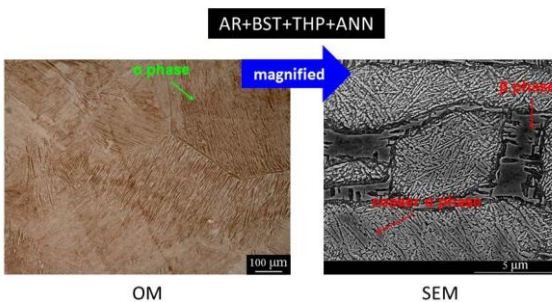


Fig.8 Optical and SEM micrographs of Ti-6-4 alloy subjected to post-THP annealing treatment (704°C / 2h / air cooling) the thicker α grains are obtained due to the effect of grain growth attributed by post-THP annealing treatment

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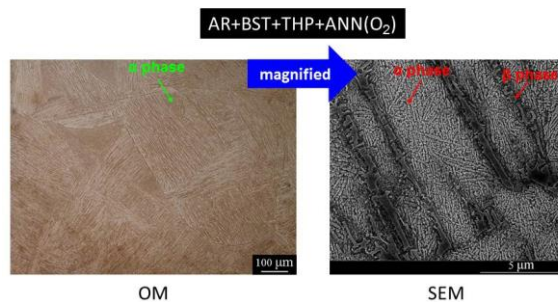


Fig.9 Optical and SEM micrographs of Ti-6-4 alloy subjected to post-THP annealing treatment with O_2

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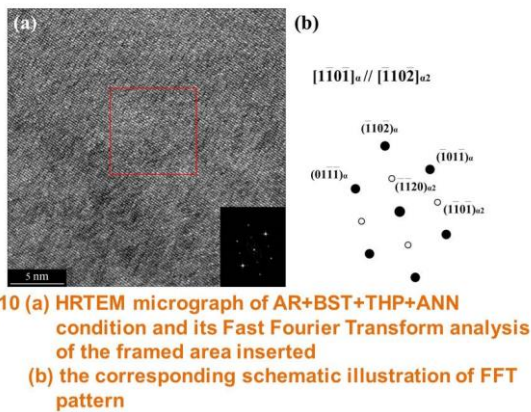


Fig.10 (a) HRTEM micrograph of AR+BST+THP+ANN condition and its Fast Fourier Transform analysis of the framed area inserted (b) the corresponding schematic illustration of FFT pattern

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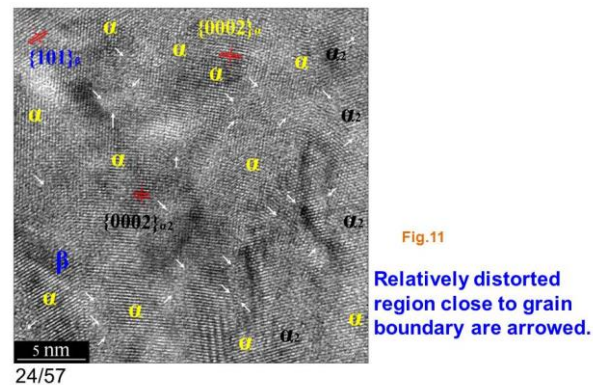


Fig.11

Relatively distorted region close to grain boundary are arrowed.

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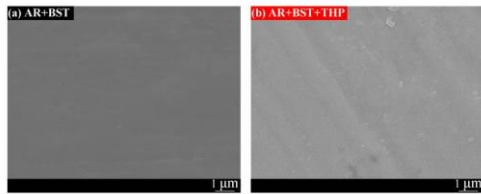


Fig.12 SEM micrographs of the top surface of oxidized Ti-6-4 alloy of AR+BST and AR+BST+THP conditions

*All the samples were ground with SIC abrasive papers and further polished with fine grade diamond paste before each stage treatment.

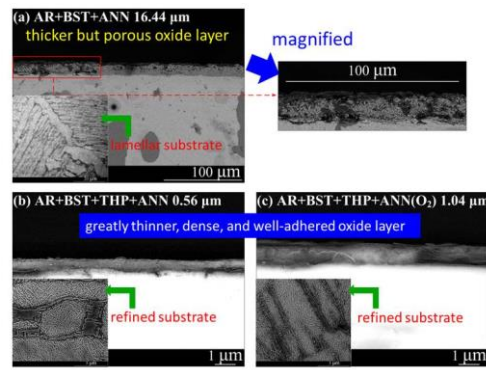


Fig.14 Cross sectional SEM micrographs of oxidized Ti-6-4 alloy after related treatments

Refined Ti-6-4 substrate producing thinner oxide layer

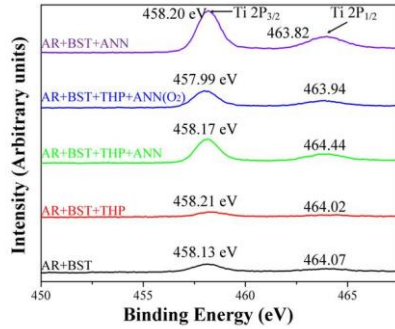


Fig.15 XPS spectra of the Ti 2p region of the top surface after related treatments

The Ti 2P_{3/2} peak was positioned at about 458.2 eV, indicating oxidized Ti⁴⁺ in the form of TiO₂ in agreement with the work of Wang et al. (JMR, Vol. 24, No. 12, pp3680-3688, 2009)

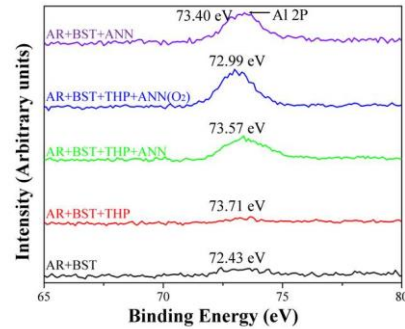


Fig.16 XPS spectra of the V 2p region of the top surface after related treatments

The Al 2P peak was positioned at about 73.2 eV, indicating oxidized Al³⁺ in the form of Al₂O₃ in agreement with the work of Wang et al. (JMR, Vol. 24, No. 12, pp3680-3688, 2009)

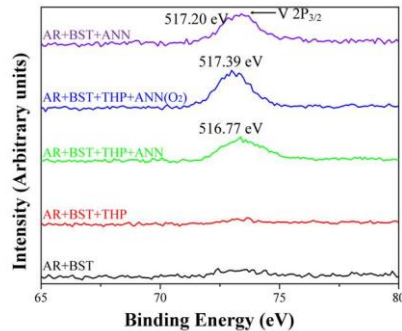
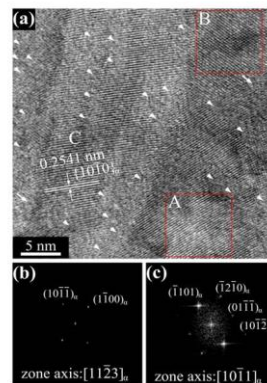
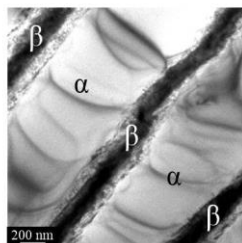
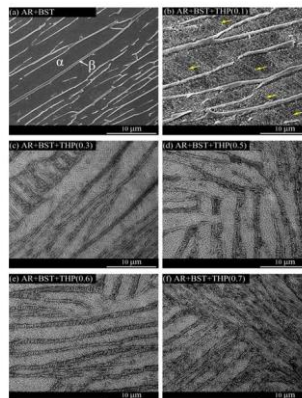


Fig.17 XPS spectra of the V 2p region of the top surface after related treatments

The V 2P peak was positioned at about 516.9 eV, indicating oxidized V⁵⁺ in the form of V₂O₅ in agreement with the work of Wang et al. (JMR, Vol. 24, No. 12, pp3680-3688, 2009)



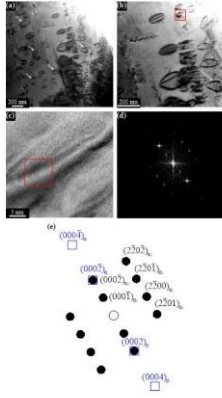


Fig.21 (Ti-6Al-4V THP loading 0.1 H/M)
Dislocation loops together with Delta phase being detected

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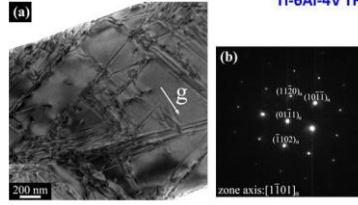


Fig.22 Ti-6Al-4V THP loading 0.3 H/M

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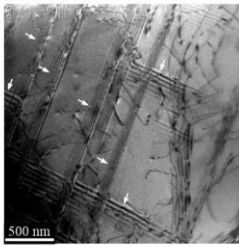


Fig.23 (Ti-6Al-4V THP loading 0.3 H/M)
Stacking faults as arrowed in TEM.

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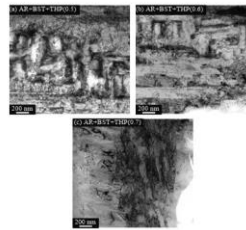


Fig.24 Ti-6Al-4V THP loading 0.5, 0.6, 0.7 H/M

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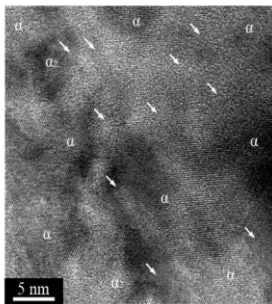


Fig.25 Well defined area as arrowed in the HRTEM image (Loading at 0.7 H/M)

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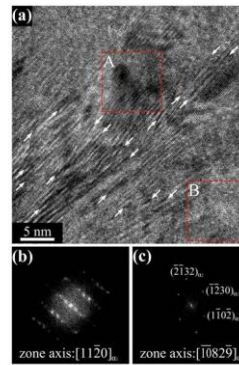


Fig.26 Stacking faults as arrowed in matrix are observed loading at 0.7H/M)

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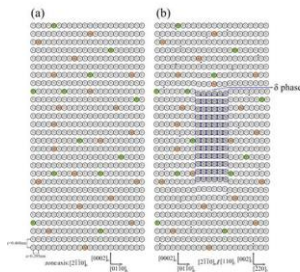
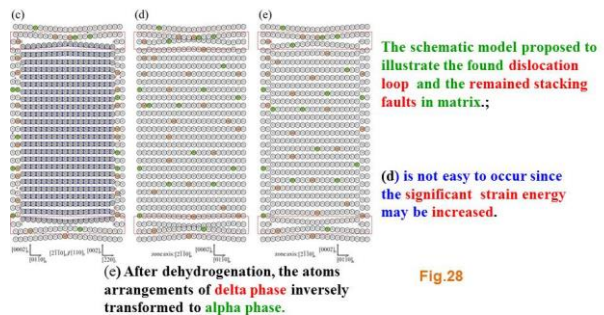


Fig.27 After THP, possible mechanism of dislocation loop formation and stacking fault produced.

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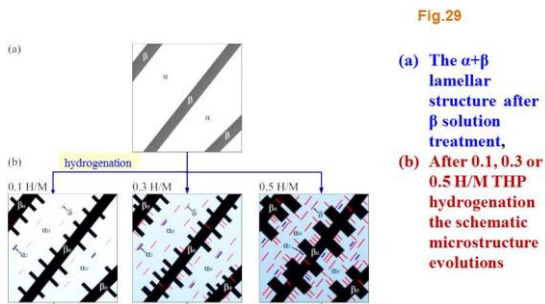


The schematic model proposed to illustrate the found dislocation loop and the remained stacking faults in matrix;

(d) is not easy to occur since the significant strain energy may be increased.

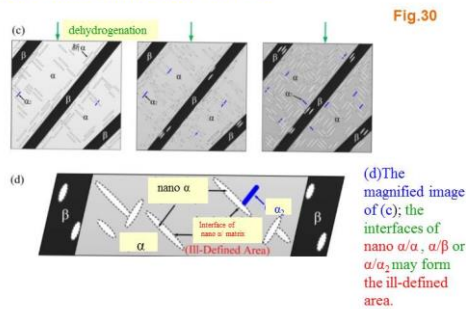
Fig.28

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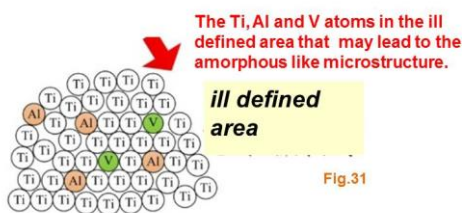


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(c) After dehydrogenation, the δ phase inversely transformed to $\alpha + \beta$ phase, resulting in a grain refinement effect.



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Conclusions

- The THP process results in the formation of refinement structures (refinement of α matrix by breaking it into several pieces) and the precipitation of α_2 (Ti_3Al) in Ti-6-4 alloy.



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Ill defined areas present the amorphous characteristics that can form an area to cut the continuity of the lattice arrangements; as a result, nano α , precipitate of nano α_2 can form refined α and β and this blocking effect can result in a grain refinement.



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Thanks for
your attention



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