

PME 4352 微機電系統導論

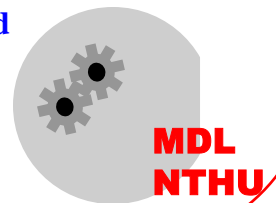
Introduction to Microelectromechanical Systems (MEMS)

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微機電系統實驗室

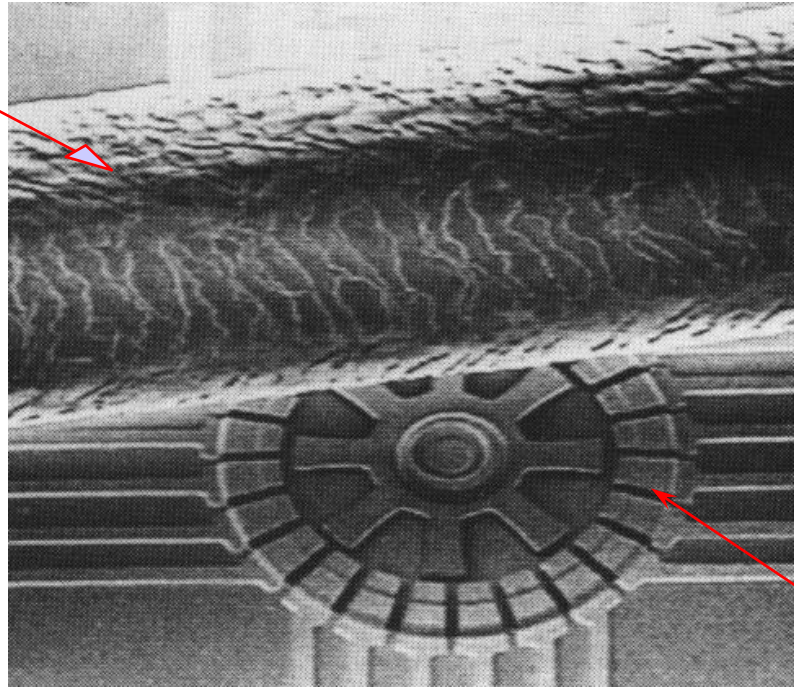
國立清華大學動機系

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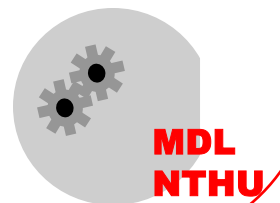
Chapter 0 Overview

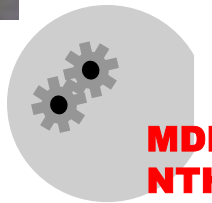
Human hair



Micromachined motor

SEM photograph by T. Boot and R.M. White at U.C. Berkeley

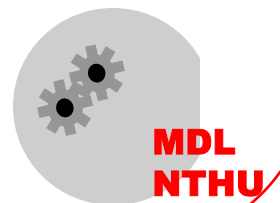




**MDL
NTU**

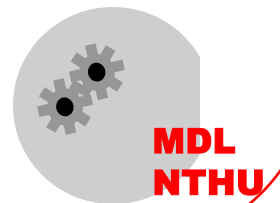
Motivation

- **Advanced technologies**
 - + **Batch and planar fabrication processes**
 - + **Miniaturization**
 - + **Precision**
 - + **Integration of electrical and mechanical parts**
 - + **SOC/SiP**
- **New topics on fundamental science, for instance**
 - + **Mechanical behaviors for micro scale devices**
 - + **Material properties**
 - + **Characterization**
- **Applications**



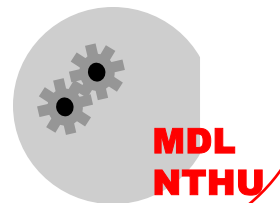
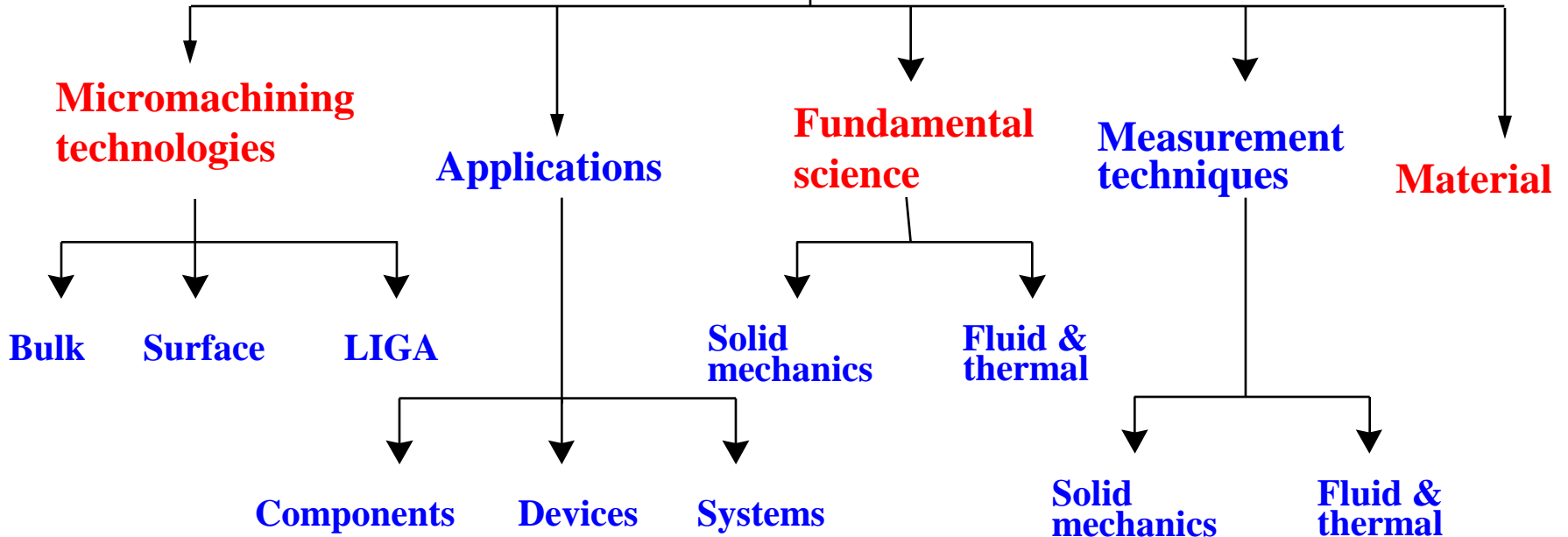
Goals

- **Design/Fabrication techniques for MEMS**
- **Applications of MEMS**
- **Mechanics issues on MEMS**
- **Expect**
 - + **Understand journal/conference/magazine articles in this field**
 - + **Conduct meaningful research in this area**
 - + **Communicate with people of different majors such as EE and Material Science**
 - + **The knowledge and concept learned here can be applied to other areas, for example: semiconductor technology, precision machining, mechatronics, etc.**



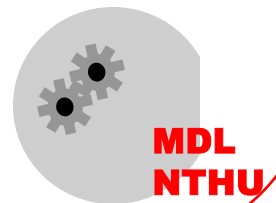
MEMS

Semiconductor fabrication processes



Useful informations

- **微系統學程** (<http://mx.nthu.edu.tw/~publish/cou5/5.htm/>)
 - + **PME 3010 微系統概論 (I)**
 - + **EE 3401 微系統概論 (II) – or PME 4352 微機電系統導論 ... etc.**
- **動機系 MEMS 相關的課程 (未更新)**
 - + **PME 5007 微系統科技應用簡介**
 - + **PME 5008 光波微機電系統**
 - + **PME 5009 電磁與微機電技術**
 - + **PME 5230 微機電傳感器**
 - + **PME 5231 微機電系統分析與設計**
 - + **PME 5358 微機電系統分析與量測**
 - + **PME 5440 超精密加工**



- 本校其他系所 MEMS 相關的課程 (未更新)

- + ENE 6350 感測與驅動元件

- + ENE 6410 微機電技術研究

- + ESS 4810 微系統製造與實驗

- + ESS 5820 微機械熱流學

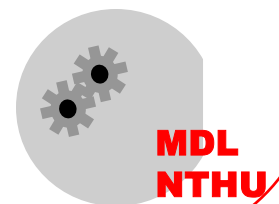
- + ESS 5841 微轉換器之原理與應用

- + ESS 5850 微系統設計

- + ESS 5860 微系統材料

- + MS 5271 微系統材料

- 可參考交大 MEMS 相關的課程



大三

微系統概論一

微系統概論二

奈米科技導論

大四

微系統製程與實驗I

微機電系統導論

高分子微系統技術

大四/研究所

微系統製程與實驗II

微系統工程原理

非矽基微奈米加工技術

研究所

微機電系統
分析與量測及實驗

微系統設計

微尺度熱流學

電子構裝力學

奈米檢測技術

微系統材料

光波微機電系統

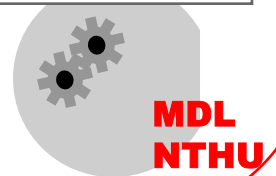
生醫微熱流

微致動器原理

微小光學元件與系統

微奈米生醫工程

感測與驅動元件



- 和半導體製程相關的課程 (未更新)

- + EE 4310 半導體製程與實驗

- + EE 5310 微電子工程

- + MS 5380 積體電路製程

- + MS 5630 薄膜物理與製程技術

- + ESS 4520 薄膜工程導論

- 其他相關的課程 (未更新)

- + EE 3350 固態電子元件

- + EE 4280 電子電路設計

- + EE 5330 積體電路元件

- + ESS 5230 半導體元件物理

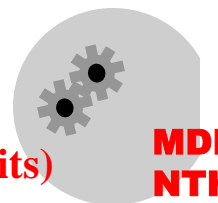
- + NS 5211 基礎光電

- + NS 6201 光學實驗

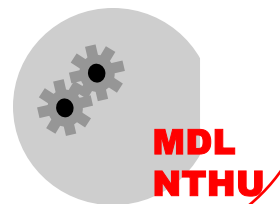
- + MS 5670 薄膜應力

- + MS 6080 感測材料

Key word: 薄膜 (thin film), 半導體 (semiconductor), 積體電路 (IC,integrated circuits)

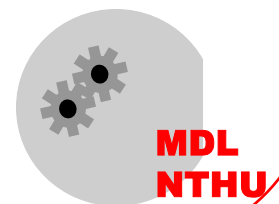


- 以下單位常有相關的**訓練課程** (可能須要收費)
 - + 位於清大的自強基金會
 - + 清大奈微中心 (前為 國科會中區微機電中心 (C-MEMS))
 - + 交大半導體中心 (SRC)
 - + 國研院－國家奈米元件實驗室 (NDL)
 - + 國研院－儀器科技研究中心 (ITRC)
 - + 國研院－國家晶片系統設計中心 (CIC)
 - + 國研院－國家高速網路與計算中心(NCHC)
 - + 工研院 (ITRI)



- 以下單位每年定期舉辦 **MEMS** 研討會
 - + 微系統暨奈米科技協會

- 以下單位不定期舉辦 **MEMS** 研討會
 - + 國研院－儀器科技研究中心 (ITRC)
 - + 國家同步輻射研究中心 (SRRC)
 - + 國研院－國家高速網路與計算中心(NCHC)
 - + 工研院 (ITRI)



- 國外 MEMS 相關之網址 (ref. to M. Madou)

- + <http://mems.isi.edu>

- + <http://mems.mcnc.org>

- + <http://www.nexus-emsto.com>

- + <http://bsac.eecs.berkeley.edu>

- + <http://www-mtl.mit.edu>

- 國內 MEMS 相關之網址

- + <http://mdl.pme.nthu.edu.tw/>

- + 工研院 <http://www.itri.org.tw/mems/>

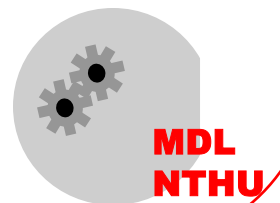
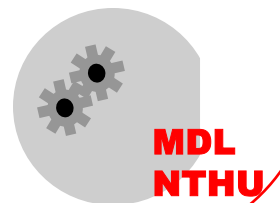


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References

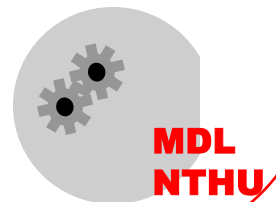
Books

+ MEMS general concept

- (1) **Fundamentals of microfabrication by M. Madou, 1997**
- (2) **Micromechanics and MEMS edited by W.S. Trimmer, 1997**
- (3) **Microsystem technology and microrobotics, S. Fatikow and U. Rembold, 1997**
- (4) **MEMS and MOEMS Technology and Applications, edited by P. Rai-Choudhury, 2001**

+ Microsensors and microactuator

- (1) **Microactuators by M. Tabib-Azar, 1998**
- (2) **Micromachined transducers by G.T.A. Kovacs, 1998**
- (3) **Microsensor by J.W. Gardner, 1994**
- (4) **Semiconductor sensors by M. Sze, 1994**
- (5) **Microsensor edited by R.S. Muller et. al., 1991**
- (6) **Silicon Sensors, S. Middelhoek and S.A. Audet, 1989**
- (7) **Biosensor: Microelectrochemical devices by M. Lambrechts and W. Sansen, 1992**



+ MEMS design

(1) Microsystem design by S.D. Senturia, 2001

+ Fabrication technology and material properties

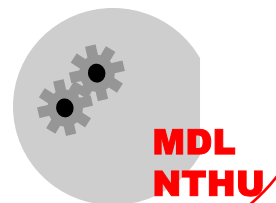
(1) VLSI 製造技術 莊達人 編著, 1994

(2) Thin film process edited by J.L. Vossen and W. Kern, 1978

(3) Semiconductor integrated circuit processign tech. by W.R. Runyan and K.E. Bean, 1990

(4) The materials science of thin films by M. Ohring, 1991

(5) VLSI technology by S.M. Sze, 1988

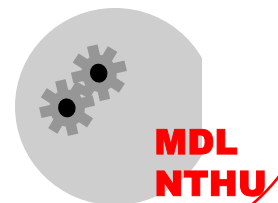


Journals

- (1) Journal of Micromechanics and Microengineering**
- (2) IEEE/ASME Journal of Microelectromechanical Systems**
- (3) Sensors and Actuators A/B**
- (4) Microsystem Technology**
- (5) Journal of Vacuum Science and Technology**
- (6) IEEE/ASME Transactions on Mechatronics**
- (7) IEEE Transactions on Electron Devices**

Conference proceedings

- (1) IEEE/ASME International Workshop on MEMS**
- (2) Transducers**
- (3) Solid-state Sensor and Actuator Workshop**
- (4) IEEE/LEOS Optical MEMS**
- (5) ASME IMECE**
- (6) Eurosensors**



(7) μ TAS

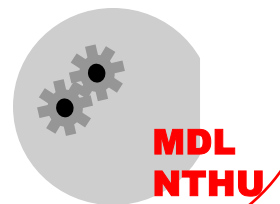
(8) HARMST

(9) BioMEMS

(10) Microsystem Technologies

(11) SPIE Symposium on Micromachining and Microfabrication

(12) Micromechanics Europe



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