The Lecture of Graduate School of Engineering, Kyoto University
"Micro/Nano Scale Material Engineering"

**Attendance FREE of charge**

# The Summer Intensive Course 2014 of GRENE project, Kyoto University

# Micro/Nano Materials Course

**※ All lectures will be given in English ※**

This class lectures focus on specific mechanical properties and behavior of micro to nano scale materials as well as underlying mechanism of those properties and behavior and characterization method. Furthermore, techniques of measurements, analysis and structural design of biomaterial such as protein and DNA which are expected to be utilized as micro nano scale materials are lectured.

**【Class Schedule】** 16, 17, 18, 19 September 2014, 10:30～18:00

**【Location】** Research Administration Center, Kyoto University
http://www.t.kyoto-u.ac.jp/ja/access/katsura (Katsura Campus)

**【Course Topics】** Please see reverse side
**Possible to attend only preferred lectures.**

**【Application】**
Please inform your ①Name, ②Affiliation, ③Tel, ④E-mail, ⑤The days wishing attendance at the lectures.
E-mail: **Office@mot.astem.or.jp**

**【Contact Us】** Please E-mail to **tahara.miki.5w@kyoto-u.ac.jp**
(GRENE Office, Micro/Nano Fabrication Hub in Kyoto University)

**【Sponsorship】** Micro/Nano Fabrication Hub in Kyoto University
・Green Network of Excellence(GRENE) ・Nanotechnology Platform

**【Co-Sponsorship】**
Advanced Scientific Technology & Management Research Institute of KYOTO (ASTEM RI)

**※ These lectures are the Kyoto University extension ※**
**※ course, but the school credit can not be acquired. ※**

※※ Shooting and recording of lectures are strictly prohibited ※※

# Micro/Nano Materials Course
# Schedule and Course Topics

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|---|---|---|---|
| 9/16 (TUE) | Outline | In this lecture, application examples of micro and nano scale material on devices and importance of mechanical properties and its behavior on device characteristics are described. | |
| | | 10：30-12：00 | Osamu TABATA (Professor) / Tomoki TANEMURA (Researcher, DENSO Corporation) |
| | Fracture and fatigue mechanism of materials in the micro- and nano-meter scale① | As a representative example of materials with microscale structures, properties of composite materials are lectured. Characterization of microscopic components such as fibers and matrices are explained from the view points of the difference from bulk materials. Testing methods and properties of fiber/matrix interface are described. The relationship between the deformation and fracture of microscopic components and those of macroscopic composite materials are explained including the underlying mechanism. Explanation is also made to anisotropy of elastic properties and strength. | |
| | | 13：00-16：15 | Masaki HOJO (Professor) / Masaaki NISHIKAWA (Associate Professor) ①② |
| | Fracture and fatigue mechanism of materials in the micro- and nano-meter scale② | We explain fundamentals on the fracture and fatigue mechanism of materials in the micro- and nano-meter scale. At first, the characteristic properties of deformation and fracture in small components such as thin films, wires, dots etc. are discussed in terms of the solid mechanics. Focus is put on the interface strength of dissimilar materials as well including the effect of fatigue, creep and environment. Then, we extend our explanation to the multi-physics property of nano-components on the basis of the ab initio simulations. | |
| | | 16：30-18：00 | Takayuki KITAMURA (Professor) / Takashi SUMIGAWA (Associate Professor) ① |
| 9/17 (WED) | | 10：30-12：00 | Takayuki KITAMURA (Professor) / Takashi SUMIGAWA (Associate Professor) ② |
| | Mechanical properties of Silicon | Silicon, one of the most widely used materrials in micro/nano devices, is used not only a semiconductor material but also a mechanical material because of its sperior mechcanical properties. In this lecture, the properties of silicon, such as physical, electrical, mechanical, electro-mechanical properties, will be presented in the view point of a mechanical structural material. Especially the lecture will focus on the elastic properties, piezoresistive effect, and fracture/fatigue properties of silicon, indespensable for designing micro/nano-devices. | |
| | | 13：00-16：15 | Toshiyuki TSUCHIYA (Associate Professor) ①② |
| | Characterization of micro nano material | In this class, first I will lecture the evaluation method for the mechanical properties of micro and nano-scale materials used for MEMS and semiconductor devices. Several representative experimental techniques for micro and nano mechanical testing will be presented and explained. Then I will lecture representative functional materials, such as shape memory alloy films and self-propagating exothermic foils, and lecture regarding the possibility of their application to MEMS. | |
| | | 16：30-18：00 | Takahiro NAMAZU (Associate Professor, Unibersity of HYOGO) ① |
| 9/18 (THU) | | 10：30-12：00 | Takahiro NAMAZU (Associate Professor, Unibersity of HYOGO) ② |
| | Piezoresistive effect of micro and nano material | In this theme, we will study the fundamental concepts of electronic-state theory and band structures to represent behavior of electrons in materials, and will discuss the electromechanical properties of materials based on the electronic-state theory. In particular, the principle and features of the piezoresistive effect, the change in the electrical resistivity due to mechanical stresses and strains, will be derived from the band structures of materials. The mechanisms of scale dependence of piezoresistivity in nanoscale materials such as silicon, carbon nanotube, and graphene will be also discussed. | |
| | | 13：00-16：15 | Koichi NAKAMURA (Associate Professor) ①② |
| 9/19 (FRI) | Bio/Nano material① | In tissue adaptation, regeneration and stem cell differentiation in tissue morphogenesis, cellular functional activities such as cell migration and division are regulated by complex mechano-chemical couplings at molecular level. To understand such a hierarchical dynamics from nanoscopic molecular events to microscopic cellular dynamics, we will discuss analysis of the molecular and cellular mechanical behaviors as bio-nano materials by integrating experiments, mathematical modeling and computer simulations. | |
| | | 10：30-12：00 | Taiji ADACHI (Professor) / Yasuhiro INOUE (Associate Professor) ① |
| | | 13：00-14：30 | Taiji ADACHI (Professor) / Yasuhiro INOUE (Associate Professor) ② |
| | Bio/Nano material② | Motor proteins are nano-scale actuators in vivo. Their active functions can be reconstructed in vitro to be utilized as a driving source of micro/nano systems. This lecture introduces fundamentals of their mechanical properties and molecular design methods. | |
| | | 14：45-16：15 | Ryuji YOKOKAWA (Associate Professor) |
| | Bio/Nano material③ | This lecture describes DNA nanotechnology to construct nanoscale structures using DNA as a structural material. Fundamental knowledge, design methodology and application of DNA origami technique are focused. | |
| | | 16：30-18：00 | Osamu TABATA (Professor) / Do-Nyun Kim (Assistant Professor, SEOUL National University) |