Micro structures and Reliability Lab.

Hyun Chul Park

Education
Ph.D. 1985 Mechanical Engineering, Univ. of Iowa
M.S. 1981 Mechanical Engineering, Univ. of Iowa
B.S. 1974 Mechanical Engineering, Seoul National Univ.

Experience

1986~	Dept. of Mechanical Engineering, Postech, Professor
1985~1986	University of Iowa, Visiting Assistant Professor
1985~	University of Iowa , Lecturer
1974~1979	Agency for Defense Researcher

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This laboratory has carried out researches on the Micro/Nano-mechanics, mechanical properties of the materials in small scale and its applications. Objectives are : improvement of the reliability for the MEMS/NEMS devices by evaluating mechanical properties accurately, and design of the micro-sensor by making use of the AAO structure. The lab is directed by Hyunchul Park, Professor in Mechanical Engineering.
On going recent research activities are in the following areas:

- **Measurement of Mechanical Properties and Size Effect**

Micro-electro-mechanical systems (MEMS) consist of various thin films the thickness of which ranges from sub-micron to tens of microns. But, the mechanical properties of such thin films are different from those of bulk materials and difficult to be identified.

We measured the mechanical property of films using the bulge test and the nano-indentation test are powerful techniques for measuring the mechanical properties of thin films. Bulge test of free standing membrane was found to be a promising method of determination of mechanical properties without being influenced by the mechanical properties of the substrate. And nano-indentation test is technique for measuring the elastic modulus and hardness of thin films and small volumes. Using the these methods, we investigate the effect of specimen size, grain size, fabrication condition and annealing on the mechanical property of films.

The mechanism based strain gradient (MSG) plasticity is one of the methods to analyze non-uniform deformation behavior in micro/nano scale. In this theory, a multiscale, hierarchical framework to facilitate such a marriage between plasticity and dislocation theory were proposed. A mesoscale cell with linear variation of strain field is considered. Each point within the cell is considered as a microscale sub cell within which dislocation interaction is assumed to obey the Taylor relation so that the strain gradient law applies.

We propose a modified strain gradient plasticity theory, which is based on MSG theory using the concept of GNDs on the grain boundaries in order to explain the size effect for polycrystalline materials. To validate the proposed model, various experimental results for polycrystalline materials such as micro tension test, bulge test and bending test were employed. The proposed model can predict the size effect in deformation for polycrystalline material which can not explain using the classical mechanics and original strain gradient plasticity theory.

- **Multibody dynamic analysis of the cold rolling mill**

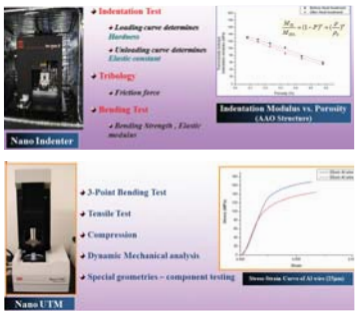
Chatter is the phenomenon caused by vibration between the workpiece and the manufacturing machine. Because the chatter reduces the quality of products in the grinding and milling operation, it constitutes a major problem. The chatter vibration of the rolling process also has a significant effect on the surface and thickness of the metal strips.

We investigated the dynamic behavior of the cold rolling mill in the Gwangyang Works of POSCO. For the experimental study, the acceleration of the roll, rolling force and speed of the work roll were measured by accelerometer, load cell and tachometer, respectively. The numerical model of the rolling mill including the driving system was built for multibody dynamic analysis. The model was validated by experiment. The effects of the rolling parameters such as rolling force and speed on chatter vibration were investigated.

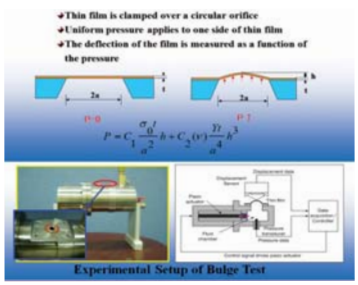
- **Design and analysis of offshore wind turbine foundation**

With the development of offshore wind energy, several types of foundation can be used to support offshore wind turbine. According to different environmental conditions, various fixed-bottom foundations, such as, monopile, tripod, jacket, and multipile are designed and analyzed to study the dynamic response of wind turbine for Korean Western Sea, where the first offshore demonstration project will be located. The influence of different issues, such as, joint can, overlapping, X-brace stress concentration, marine growth, soil-structure interaction, are investigated for specific foundations.

Nane Indentation and UTM



Bulge Test



Major Publications

- D. Kim, W. Hwang, H.C. Park, K.H. Lee, "Superhydrophobic nanostructures based on porous alumina", Physics, Volume 8, Issue 6, October 2008, Pages 770-773.
- Donghyun Kim, Hyun Chul Park, Kun-Hong Lee, Ki-Bae Park, Kangduk Choi, Woonbong Hwang, "Overcoming of nanoscale adhesion by electrostatic induction", CURRENT APPLIED PHYSICS, vol.9, No.3, pp.703-706, 2009.05.
- Youngdeuk Kim, Bongbu Jung, Hunkee Lee, Hyejin Kim, Kunhong Lee, Hyunchul Park, "Capacitive humidity sensor design based on anodic aluminum oxide", Sensors & Actuators: B. Chemical, vol.141, No.2, pp.441-446, 2009.9.
- Hun-kee Lee, Bong-bu Jung, Young-deuk Kim, Woon-bong Hwang, Hyun-chul Park, "Analysis of flow stress and size effect on polycrystalline metallic materials in tension", MATERIALS SCIENCE & ENGINEERING, in press, vol.527, Issues 1-2,pp.339-343, 2009.12.
- W. Hwang, K. H. Lee, H. Park, J. Kim, J. Park, J. H. Cho, J. H. Jeon, D. Choi, D. Kim, D. Kim, S. Kim, K. Lee, T. Jing, and S. Lee "Some aspects of the design and applications of nanohoneycomb and nanofiber array structures" Mechanics of Composite Materials, Vol. 47, No. 1, (2011.3), pp.11~36.
- Hunkee Lee, Bongbu Jung, Dongseob Kim, Hyunchul Park "On the size effect for micro-scale structures under the plane bulge test using the modified strain gradient theory" International journal of precision engineering and manufacturing, Vol.12, No.5(2011.10) pp.865-870.