Abstract of Keynote Speech 2

Materials Strength in Nanoscale

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Abstract

As materials in nanoscale dimensions (nanomaterials) are used in various applications such as semiconductors, small sensors, and micro- and nano-electromechanical-systems (MEMS and NEMS), it is inevitable to understand their mechanical behavior for keeping high reliability in manufacturing and in service. Especially, the focus must be put on the fact that the mechanics for materials in nanoscale is significantly different from that in macroscale counterpart.

Moreover, in a macro component, since the fracture is local phenomenon, it is strongly affected by the microstructure of materials. Then, it is necessary to understand the fracture process in nanoscale for developing high-performance materials. The focus should be put on the detailed mechanics of grouped defects.

In materials strength in nanoscale, the internal nanostructures such as dislocations, grain boundaries, and various defects govern the mechanical properties coupling with the external structures (geometric factor), shape and size of components. Since the conventional mechanics is developed for describing the strength/fracture laws of materials from the viewpoint of macroscale, it is essential for understanding of characteristics in nanoscale to investigate the applicability of its fundamental concept to nanomaterials as well as to explore exotic mechanical phenomena on the basis of nanomechanics, namely the fracture nanomechanics*.

However, the experiments in these scales are extremely challenging in fabrications, handlings, and inspections of the specimen and in measurements/controls of load and displacement during the test. In this project, we have developed the methodology and conducted experimental and analytical studies on the strength nanomaterials in the nano and atomic scales. The knowledges in the fracture and fatigue in terms of the nanomechanics can provide crucial insights for the reliability of not only small devices but also large components.

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*Kitamura T., Sumigawa, T., Hirakata, T. and Shimada, T., *Fracture Nanomechanics, 2nd Edition,* 2016, Pan Stanford Publishing.