【Grant-in-Aid for Scientific Research (S)】

Broad Section C

Title of Project : Design on Mechanical and Multi-Physics Properties of Nano-Structured Meta-Interface

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Keyword : Nano-structure, Meta-interface, Mechanics, Multi-physics, Design

【Purpose and Background of the Research】

As a small device consists of many kinds of materials, dissimilar interfaces are inevitably included inside it. The material properties at interfaces are inferior in general. This project aims to investigate novel properties of nano-structured meta-interface on the basis of inquiry of their mechanisms in detail, and to contribute the innovative design of devices.

(1) We develop a methodology to examine the mechanical properties of a nanometer-scaled (10-30nm) element, which composes the meta-interface, and evaluate the effect of geometry and size of single element.
(2) Considering the interaction, we design the mechanical function of meta-interface. We experimentally examine it as well.
(3) We develop a methodology to examine the multi-physics (ferro-magnetics, ferro-electrics, mechanics and so on) properties of the nanometer-scaled element and investigate the characteristics of meta-interface.

【Research Methods】

We have a technique to make a layer composed of numerous nanometer-scaled elements by a dynamic oblique deposition method. The shape and size of elements can be precisely controlled (sculptured nano-elements; see Fig. 1). The nano-structured meta-interface can be formed by the method and we recently get some clues of innovative functions by preliminary investigations. Thus, we will develop equipment to examine the mechanical behavior of nano-elements (Fig.2) and will inquire the property of the interface. Then, by the first principle simulation and conversion of equipment, we will extend our challenge toward the multi-physics properties of nano-structured meta-interface.

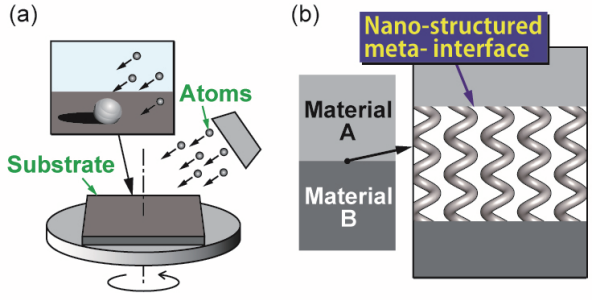

Figure 1 (a) Dynamic oblique deposition, (b) Nano-structured meta-interface.

【Expected Research Achievements and Scientific Significance】

While a dissimilar interface in a device has been considered as weak point in general, we can introduce innovative mechanical properties by this research exploring mechanics on deformation of nano-elements and interactions among numerous elements.

We extend the function to multi-physics properties in nanometer scale. We try to establish a new scientific field; mechanics and multi-physics in assembled nano-structures.

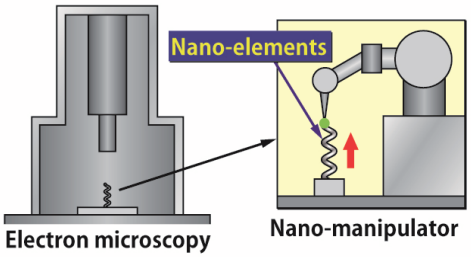

Figure 2 Equipment to examine the mechanical behavior of nano-elements.

【Publications Relevant to the Project】

T. Kitamura, T. Sumigawa, H. Hirakata and T. Shimada, "FRACTURE NANOMECHANICS" 2nd Edition (Pan Stanford Publishing Pte. Ltd., (2016)), ISBN 978-981-4669-04-7.
Y. Umeno, T. Shimada, Y. Kinoshita and T. Kitamura, "MULTIPHYSICS IN NANOSTRUCTURES" (Springer, (2017)), ISBN 978-4-431-56571-0.

【Term of Project】 FY2018-2022

【Budget Allocation】 150,700 Thousand Yen

【Homepage Address and Other Contact Information】

https://www.me.t.kyoto-u.ac.jp/ja/research/introduction/zairyoubussei