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

Science and Engineering (Engineering)

Title of Project : Creation and development of high-order nano-space structures through innovative control of stress field

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Research Project Number : 17H06146 Researcher Number : 60312609
Research Area : Mechanics of Materials, Nanomaterial Engineering
Keyword : Nanomaterial and fabrication process, Nanostructure, Mechanics of nanomaterials

【Purpose and Background of the Research】

This research will establish a radical manufacturing method for high-quality metallic and semiconductive nanospace structures that are highly ordered and highly dense by explaining the diffusion phenomenon of atoms in stress fields. High degrees of control for shapes, dimensions, and spatial positions of nanospace structures will be achieved to realize a low-resistance and high-transmittance transparent conductive film, and a low-cost high-conversion-efficiency solar hydrogen manufacturing device.

【Research Methods】

The diffusion velocity of metallic atoms and the formation velocity of surface oxidation films will be investigated in detail. The control of the atomic arrangements and molecular formations during the growth process will make it possible to control shapes, dimensions, and positions of the ultra-high-quality, highly ordered metallic and semiconductive nanostructures. The mechanisms for the formation of various nanostructures will be systematically explained by expounding on the effects of the stress gradients arising from the thermal expansion of materials and the volumetric expansion due to the oxidation film on the atomic diffusion rate. Furthermore, the effects of the temperature, humidity, and catalyst on the formation rate of the material surface oxidation film, along with the effects of the stress concentrations, crystalline structure, and atomic density on the formation of nanostructures, will also be examined. The formation of a transparent conductive film with a low-resistance that offers a high-transmittance, and a solar hydrogen manufacturing device at a low cost that offers an ultra-high-conversion efficiency will also be carried out.

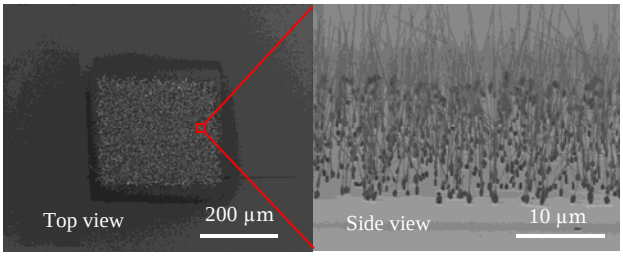

Fig.1 High density Al nanowires

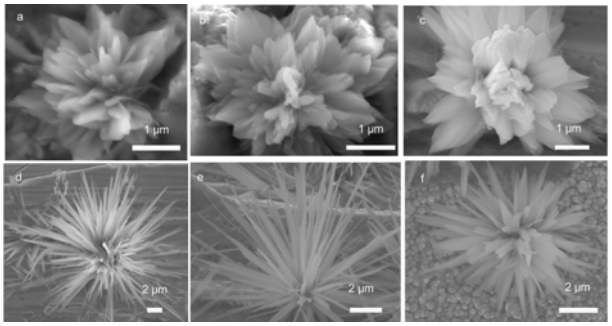

Fig.2 Different structured Cu_2O nanoflowers

【Expected Research Achievements and Scientific Significance】

It will be possible to develop devices which will, in turn, resolve the current issues of transparent conductive film manufacturing cost and solar hydrogen decomposition efficiency in a single sweep, bringing about significant contributions to society.

【Publications Relevant to the Project】

・L. Hu, Y. Ju, M. Chen, A. Hosoi, S. Arai, Growth of Cu_2O Flower/Grass-like Nano Architectures and their Photovoltaic Effects, Applied Surface Science, 305, 710-715, 2014.
・Chen Y. Yue, and Y. Ju, Growth of Metal and Metal Oxide Nanowires Driven by the Stress-induced Migration, Journal of Applied Physics, 111, 104305-1-6, 2012.

【Term of Project】 FY2017-2021

【Budget Allocation】 161,000 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.mech.nagoya-u.ac.jp/ju/index_E.html