Formation of Metallic Nanomaterials by Controlled Atomic Accumulation and their Characterizations

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【Outline of survey】

Recently, self-organization, a phenomenon of controlling the structural order of a material by molecular process, has been received considerable attention for generating nanomaterials from individual atoms and molecules. However, for realizing the formation of nanomaterials by self-organization, the currently available chemical methods are only a few. Not only that, they are found to be influenced significantly by the chemical composition of the associated materials. In the present research, a method is developed for controlling the atomic diffusion and accumulation. In fact, the atoms diffused by the electron wind due to high current density produce compressive stresses in the target material, and the rapid release of the stress allows the rearrangement of the atoms at a desired location. The central objective of the present research is to establish the scientific bases of the mechanisms for controlling the atomic diffusion as well as the accumulation of diffused atoms for realizing the formation of metallic nanomaterials with a desired geometry (*i.e.*, the diameter, length, shape, etc.) at a desired location of interest. Moreover, the physical properties of the fabricated nanomaterials are investigated thoroughly for their effective future applications. The following subjects are considered for the present research: (1) Mechanism of atomic diffusion and accumulation, (2) Fabrication of metallic nanomaterials, (3) Evaluation of mechanical and electromagnetic properties of nanomaterials, (4) Application of nanomaterials, and (5) Realization of their mass production.

【Expected results】

Scientific foundation will be developed for forming the metallic nanomaterials by controlling the atomic diffusion/accumulation, as being independent of chemical composition of the material. The metallic nanomaterials, for example, the nanowire, nanocoil, nanotube and nanoball, are expected to show extremely high material strength, and therefore, are being considered as new strength materials of future. Furthermore, the metallic nanomaterials are of great practical value, especially, for the future nano-electronics, which will eventually lead to the realization of highly integrated circuits with excellent performance, for example, low power consumption, low heat dissipation, etc.

【References by the principal researcher】

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• M. Saka and R. Ueda, Formation of Metallic Nanowires by Utilizing Electromigration, J. Mater. Res., Vol. 20, No. 10 (2005), pp. 2712–2718.

【Term of project】 FY2006－2010

【Budget allocation】23,400,000 yen

【Homepage address】 http://king.mech.tohoku.ac.jp/saka/E-Top-page.htm