21st COE Seminar Series #8

Department of Materials Engineering
The University of Tokyo

Nano-powder of Transition Metals Produced through Homogeneous Reduction

by

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Reducing particle size to the range of nano-meters scale (<100 nm) will bring new and unique property to the materials. Those nano-materials are highly focused in developing new devices. An example of nano-powder application is nano-capacitor: reduction in particle size from the current value of around 0.5 mm to something nearer 10 nm would significantly improve the performance of capacitors. However, the current technology of powder producing by thermoreduction in molten salt is beyond the possibility of nano-particle production. Two facts in the molten salts thermoreduction limit the particle size of the product powder: 1) high processing temperature results in an undesirably high rate of particle growth; 2) the reductant (sodium in the case of tantalum production) is immiscible in the molten salt diluent promotes heterogeneous nucleation of product metal. Therefore the ideal condition for nano-particle production through a chemical reactions involving precipitation would be a homogeneous reaction. For the case of a reduction reaction this requires a common solvent which can both dissolve feed salt and reductant. From the perspective of establishing favorable conditions for making ultrafine powder, metal-ammonia solutions possess ideal electrical properties and are stable at subambient temperatures (low temperatures enhance nucleation and restrain growth). This method of producing nano-particles of transition metals was performed in reducing tantalum and niobium salts and nano-powders of average particles size around 20 nm were obtained. The method was also extended to produce nano-powder of intermetalic compound by one-step reduction directly. In this presentation, the theory and experimental results will be discussed, and the unique route for producing nano-particles will described in detail.

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