CONTINUOUS PRODUCTION OF NANOPHASE METALS, METAL OXIDES AND MIXTURES USING A MICROWAVE-DRIVEN POLYOL PROCESS*

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We have been developing a system for large scale, continuous production of nanophase metals, metal oxides and other nanophase materials. Note that similar processes can also be used to produce other metal compounds such as sulfides and nitrides. This system is based on a 6 kW S-Band source (2.45 GHz) with relatively low capital cost, and employs a single pass, waveguide system with the reactants flowing through a silica tube placed along the centerline of the waveguide, ensuring good coupling of the microwave power into the reactants. The polyol process used here employs an organic solvent such as ethylene glycol to reduce a metal salt, at high temperature, to the metal oxide or the metal. The microwave system here is used to rapidly heat the solution to a high temperature as it flows through the microwave system. Our system has the potential for production of kilograms of product per day in contrast to most batch processes for production of nanophase materials. The continuous microwave polyol process also has a number of other potential advantages, including uniform products through a well-controlled continuous process, avoiding lot-to-lot variations as might result from batch processes. The process also has the potential for production of much smaller particle sizes than can be produced in a large-scale batch process, and well as narrower particle size distributions, the former from the very short process time involved (approx. 10 seconds), and the latter from the constant thermal history for all products. We will describe some of our experimental results for production of various types of nanophase metal powders, mixtures of nanophase metals, nanophase metal particles coated with other metals, and nanophase metal oxides. We will also present results for models of the process that incorporate a number of critical features, such as temperature-dependent properties, to provide accurate description of the process and effects of various process and material parameters on the thermal history seen by reactants and products.

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