The effects of process variables on Cu coated Al_2O_3 powder by spray drying

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Introduction

Recently, metal matrix composites reinforced with ceramic particles are attracting growing interests from many industrial sectors because of their relatively low fabrication cost and ability to tailor mechanical or thermal properties. The agglomeration of the ceramic particles in the metal matrix and poor matrix-particle interface are the most common technical difficulties to ensure reliable properties of the composites. Ceramic particles coated with metallic elements were found effective for improving uniform dispersion or interfacial cohesiveness. Several coating techniques such as electroless plating, fluidized bed CVD, coprecipitation, have been reported to coat ceramic particles. In this study, we applied spray drying process to produce metal-ceramic composite powders.

Experimental

Aqueous primary slurry was made from $Cu(NO_3)_2 \cdot 6H_2O$ metallic salt and reacted with NH_4OH solution, varying the reaction time and pH level of the mixture. The primary slurry was filtered in vacuum, and mixed with 44㎛ Al_2O_3 powders and D.I. water to make the secondary slurry of varing viscosity. The secondary slurry was spray-dried to produce Al_2O_3 powders coated with the primary slurry. The slurry coated powders were reduced at 400℃ under H_2 atmosphere to produce copper-coated Al_2O_3 particles. The coated powders were examined by SEM for morphology and analyzed by ICP for the metal/ceramic ratio. In order to study the coating effect, the coated powders were mixed with aluminum powder, and evaluated for the sintering behavior.

Result

The viscosity of the primary slurry decreased with reaction time, and also with pH level when reaction time was fixed for 2 hours. After spray drying, ceramic particles coated with the slurry were produced. The salt in the slurry was completely removed by the reduction to produce copper coated Al_2O_3 particles. SEM and XRD analysis revealed that the uniformity and adherence of the copper coating to alumina particles were affected very much by the process variables for making the primary slurry; when reaction time was fixed for 2 hour, alumina particles was covered with primary slurry for pH 6, 7 very well. Therefore pH level of 6 or 7 would be optimum while pH 5 gave very poor slurry coating. Cu content of these powders was 53% for pH 7, 44% for pH 6 respectively. The as-sintered microstructure by SEM revealed Cu-Al liquid phase was formed along the aluminum matrix powder boundaries and also at the interface of matrix/Al_2O_3 particles, enhancing the sintering.

Conclusion

Decreasing reaction time and lowering pH value reduced slurry solution viscosity. After reduction, The uniformity and adherence of the coated layer varied with the pH level of the reaction solution. Therefore Optimum combination of viscosity and pH level of the primary slurry is most critical to produce a good quality copper-coating

on Al_2O_3 particles. The coated powder was found effective for improving the sintering of aluminum base composite by forming Al-Cu liquid phase at the matrix/Al_2O_3 interface.

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