World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:11, No:09, 2017

Production of Metal Matrix Composites with Diamond for Abrasive Cutting Resistance by Gas Infiltration Casting

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Abstract : Metal matrix composites (MMCs) have been explored for many applications for many decades. Recently, this includes investigations for thermal applications associated with electronics, such as in heat sinks. Here, to promote thermal conductivity, composites of a metal matrix with diamond particles are used. However, this class of composites has not yet been extensively examined for mechanical and tribological behavior, especially for applications that require extreme mechanical and tribological strength, such as the resistance to abrasive cutting. Therefore, this research seeks to develop a composite material with metal matrix and diamond particles which resist abrasive and cutting forces. The development progresses through a series of steps, exploring methods to process the material, understanding the mechanics of abrasive behavior and optimizing the composite structure to resist abrasive cutting. In processing, infiltration casting under gas pressure has been applied to molten aluminum to obtain a significant penetration of the metal into a preform of diamond particles. Different diamond particle sizes were used with different surface modifications (coated/uncoated), and to compare resulting composites with the same particle sizes. Al-1 wt.% Mg as a matrix alloy was utilised to investigate the possible effect of Mg on bonding phases during the infiltration process. The mechanical behavior and microstructure of the materials produced have been characterised. These tests showed that the surface modification of the diamond particles with a reactive material (Ti-coating) has an important role for enhancing the bonding between the aluminium matrix and diamond reinforcement as apparent under SEM observation. The effect of this improved bond is seen in the cutting resistance of the material.

Keywords : aluminium, composites, diamond, Ti-coated, tribology
Conference Title : ICCEMMS 2017 : International Conference on Composite Engineering, Materials, Mechanics and Structures
Conference Location : Rome, Italy
Conference Dates : September 18-19, 2017