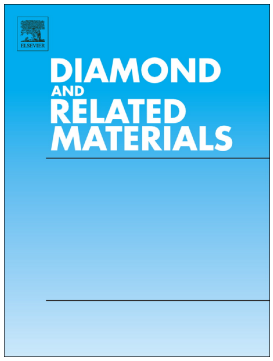

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Application of nanodiamonds for *in situ* synthesis of TiC reinforcing nanoparticles inside aluminium matrix during mechanical alloying

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Abstract

Method of *in situ* synthesis of TiC nanoparticles inside aluminium matrix directly during mechanical alloying from aluminium, titanium and nanodiamonds is developed. For this method, nanodiamonds were used as carbon material and as intensificator of mechanosynthesis during the ball milling. Optimal content of matrix material was determined. If the amount of aluminium falls below the optimal level, the synthesis becomes extremely intensified; it means that during short period a large amount of heat is released, which causes substantial grinding jars heating and frequently results in melting of sealing gaskets and other process failures. In case the amount of aluminium in the mixture grows beyond the optimal level, the synthesis process is slowed down. Optimal composition for obtaining TiC nanoparticles inside aluminium matrix is following: $43\%_{wt}Al + 57\%_{wt}TiC$. Average size of nanoreinforcements of developed composite equals 31 nm. Developed material can be applied in casting technologies as an individual product and as a master alloy.

Keywords: carbides; composites; nanoparticles; high resolution electron microscopy; microstructure.

1.Introduction

Scientific and technological developments are impossible without new materials with improved performance. On the one hand, improved materials allow enhancing the quality of various products and increasing their service life, and on the other hand, they allow creating new technical solutions that are fundamentally different when compared to the existing ones. Perspective materials include metallic composites that allow achieving material properties of a new level unattainable in conventional non-reinforced metals and alloys. Substantial attention is still paid to composites with powder-like reinforcing particles [1, 2]. Numerous studies are dedicated to the development of nanocomposites. e.g., the composites with nanosized reinforcing particles [3-6]. Nano-powders exhibit a number of features, such as developed surface and high activity of the material, which result in any amount of foreign matter and contamination on the surface of nanoparticles. Contamination between a reinforcing particle and the metallic matrix is one of the most crucial issues that restricts the wide application of nanocomposites in the industry, since in spite of the small amount, these contaminations and inclusions reduce the bonding strength between composite components. In casting technologies, contaminations and inclusions on the surface of nanoparticles result in reduced wettability between the components, which at least causes irregular distribution of reinforcing particles in the matrix, and more often – their removal from the molten mass. To reduce contaminations when applying nanopowders, various technologies are developed. For instance, the *in situ* synthesis of nanoparticles in the matrix is quite a promising one. In this case, the synthesized particles have no contact with the air, and contaminations between a reinforcing particle and the metallic matrix cannot form. The