Synthesis of Aluminum-Titanium Carbide Composites by the Rotating Impeller Gas-Liquid In-situ Method

Abstract

The next generation of aluminum automotive engines will have to operate at temperatures approaching 300°C. Traditional aluminum alloys cannot perform at these temperatures, but aluminum alloys reinforced with fine particles can. The objective of this research is to develop a process to synthesize Al-TiC composites by the Rotating Impeller Gas-Liquid In-situ method. This method relies on injecting methane into molten aluminum that has been pre-alloyed with titanium. The gas is introduced by means of a rotating impeller into the molten alloy, and under the correct conditions of temperature, gas flow, and rotation speed, it reacts preferentially with titanium to form titanium carbide particles. The design of the apparatus, the multi-physics phenomena underlying the mechanism responsible for particle formation, and the operation window for the process are first elucidated, then a parametric study that leads to the synthesis of TiC reinforced aluminum is described. Finally, potential technical obstacles that may stand in the way of commercializing the process are discussed and ways to overcome them are proposed.