

Enhanced NiTi-TiC Composites for Ballistic Protection: Effect of Reinforcement Origin and Milling Strategy

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Recent advances in ballistic protection emphasize the need for weight reduction and efficient energy dissipation. Replacing conventional polymer layers with metal matrices reinforced with ceramic particles offers a promising alternative^{1,2}. This study investigates NiTi-based composites reinforced with TiC particles, using both commercially available TiC powders and TiC produced via mechanical alloying of Ti with graphene or through plasma-catalytic pyrolysis. NiTi was selected for its excellent mechanical properties, including high strength and toughness and lower density³. Initially, hand-mixed composites with varying TiC contents were assessed; however, compositions exceeding 12.5 wt.% exhibited poor cohesion after sintering. To enhance the microstructure, mechanical milling at 800 rpm was employed. Milling for 0.5 h significantly modified the phase composition, resulting in the formation of TiNi_3 and Ni_4Ti_3 phases. After 2 h of milling, the Ni_4Ti_3 phase disappeared, with improved TiC dispersion and increased wear resistance. However, the overall presence of hexagonal phases negatively affected the mechanical properties, prompting the application of thermal treatment to improve ductility. These findings underscore the advantages of mechanical alloying in achieving uniform particle dispersion and favorable phase transformations in NiTi-TiC composites, advancing their potential for high-performance ballistic applications. The authors wish to thank the Czech Science Foundation (project no. 25-15757S, Plasma valorization of waste into cutting-edge cermet composites for high kinetic energy dissipation) for its financial support.

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