DuplexCER

High performance duplex ceramics for efficient machining of nickel superalloys

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Abstract

The main objective of the DuplexCER project is to develop and validate a new generation of high-performance sintered composites characterised by desirable functional properties and dedicated for high-speed machining cutting tools of hard-to-cut materials, especially the nickel-based family of superalloys. The project also involves investigating the use of Critical Raw Materials (CRM) from recycled WC-Co scrap as a feedstock for the production process of DuplexCER composites.

Our research focused on the development of ceramic matrix composites (CMCs) in which oxide (Al_2O_3, ZrO_2) and carbide phases form an interpenetrating "duplex microstructure". Such CMCs may be a promising tool material utilizing WC recovered from WC-Co scrap.

The five groups of DuplexCER composite materials containing various carbides were designed. Each composition consisted of Al_2O_3 + ZrO_2 + MC, where MC was one of the following metal carbides: WC, WC form recycling, WTiC composite powder, TiC or ZrC.

The composite with WC, sintered by SPS at 1550 °C, had the highest hardness (HV1=21.5 GPa), fracture toughness (K_{IC}=5.8 MPa·$m^{1/2}$) and cutting performance when turning of Inconel 718. The composite containing recycled WC was slightly weaker than the composite made from “fresh”, commercial WC, but its properties still remained at a satisfactory level.

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