Impact of Dissolution of Cast Tungsten Carbide on the Wear Behavior of CTC/Ni Metal Matrix Composites

M. Ciurans-Oset[1,2]*, J. Mouzon[2], F. Akhtar[1]

[1] *Division of Materials Science, Department of Engineering Sciences and Mathematics, Luleå University of Technology, SE-971 87 Luleå, Sweden;*
[2]*Höganäs Sweden AB - Metasphere, Upplagsvägen 28, SE-972 54 Luleå, Sweden*

*marina.ciurans@ltu.se

☒ Oral presentation ☐ Poster presentation

ABSTRACT

Cast tungsten carbide (CTC) consists in a biphasic structure of WC lamellae in a W_2C matrix resulting from the eutectoid decomposition of W-3.9 wt.% C. Hardfacing of steel tools is the main industrial application of CTC powders, where metal matrix composite (MMC) wear-resistant overlays are deposited by means of conventional welding techniques. Self-fluxing nickel alloys are the most commonly used matrix materials for dispersed CTC particulate reinforcing phase. Overall performance and mechanical integrity of these overlays is affected by dissolution of CTC particles into the matrix phase due to high processing temperature. In this study, a powder blend containing 60 wt. % spherical CTC (71-150 µm) + 40 wt. % Ni-based matrix was used to deposit hardfacing overlays onto tool steel substrate by means of laser cladding. Scanning electron microscopy (SEM) and Energy-dispersive X-ray spectroscopy (EDS) revealed significant dissolution of WC into the surrounding matrix for all specimens. Reprecipitated W-rich carbide crystals ranged from fine and rather equiaxed for low energy input, to coarse and highly dendritic for high energy input. In a quest for completely avoiding dissolution of CTC particles, spark plasma sintering (SPS) was used to consolidate substrate-free CTC/Ni MMCs with significantly lower energy input and reasonably high cooling rate. SEM and EDS investigation of SPS-sintered MMCs revealed no WC dissolution followed by reprecipitation of W-rich carbides. Fracture toughness was estimated by means of microindentation fracture, and tribological testing was used to evaluate the impact of reprecipitated crystals on the wear behavior of CTC/Ni MMC's.