

Co-operative enhancement of mechanical properties and pitting corrosion performance for additively manufactured type 420 stainless steel with spherical tungsten carbides

Yiqi Zhou^{1*}, Shuoyang Wang¹, Decheng Kong², Tingting Liu¹, Yu Yan¹, Li Zhang³,
Xiaogang Li¹, Xuanhui Qu¹, Dirk Engelberg⁴, Chaofang Dong¹

1. *Beijing Advanced Innovation Center for Materials Genome Engineering, Institute for Advanced Materials and Technology, University of Science and Technology Beijing, Beijing 100083, China*
2. *Shanghai Key Laboratory of Advanced High-temperature Materials and Precision Forming, School of Materials Science and Engineering, Shanghai Jiao Tong University, Shanghai 200240, China*
3. *State Key Laboratory of Powder Metallurgy, Central South University, Changsha 410083, China*
4. *Metallurgy and Corrosion, Department of Materials, The University of Manchester, M13 9PL, Manchester, UK*
ustbyiqizhou@ustb.edu.cn

Abstract Our study combines type 420 stainless steel enhanced with spherical cast tungsten carbide (WC/W₂C) powder to produce laser powder bed (LPBF) fusion processed metal matrix composites (MMCs). The size of utilized raw powders for the additive manufacturing process was controlled, with the resulting LPBF Type 420 + 5 wt% WC/W₂C microstructure consisting of austenite, martensitic, and W-rich carbides (WC/W₂C, FeW₃C, M₆C, and M₇C₃) ranging from nm- to μm- length-scales. The spherical cast WC/W₂C demonstrated exceptional compressive strength and wear resistance. The incorporation of W and C from reinforced particles enhanced the resistance to pitting corrosion, resulting in WO₃ and austenite phase formation. The underlying mechanisms contributing to the enhanced mechanical properties and corrosion resistance are discussed, offering valuable insights to advance the application of MMCs through LPBF additive manufacturing routes.

Keywords Laser powder bed fusion; Metal matrix composite; Pitting corrosion; Bipolar electrochemistry; Wear performance