Next Generation Iron Based PTA Weld Materials

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ABSTRACT

Improving the wear resistance of surfaces on existing industrial parts, devices, and machines by providing a hard protective surface layer is the basis for hardfacing and can result in the development of low-cost material systems since often a relatively low cost substrate can be used with an advanced hardfacing coating. Toward this end, new iron based alloys were developed for industrial hardfacing via plasma transferred arc-welding (PTAW). The alloys were designed with low critical cooling rates for metallic glass formation so that high undercoolings were achieved before nucleation resulting the achievement of fine grain and phase sizes. The starting powders were manufactured from uniform liquid melts and the formation of high volume fractions of complex borocarbides were a result of the solidification sequence and not from the addition of separate carbide or boride powders. The influence of composition and processing on the resulting hardness and toughness properties of the newly developed weld alloys are explored in this study. High hardness in the PTAW weld deposits up to R_c 66 is developed from the fine structure consisting of a high volume fraction of complex $M_{23}(BC)_6$ and $M_7(CB)_3$ borocarbides phases. High toughness up to 73.3 $MPam^{1/2}$ was developed due to the effective distribution of fine carbide and boride phases distributed in ductile alpha-iron and gamma-iron dendrites and cells. This distribution of hard ceramic phases intermixed with the ductile dendrites /cells was found to be key to obtaining high toughness in PTAW hardfacing alloys and can be adequately described through a Crack Bridging Model.