Cracking Susceptibility of AISI 1013 Steel – Copper Alloys

Class 6

The tool and die industry would like to exploit copper’s high thermal conductivity in order to improve thermal management in dies constructed of tool steel. Copper is typically considered a contaminant in steel and is a known promoter of solidification cracking in ferrous alloys. A solution to the solidification cracking dilemma will potentially allow copper to be functionally graded into steel using newly developed direct metal deposition manufacturing technology. The first step in a research effort to produce such dies was to identify the compositional cracking range of copper in steel. AISI 1013 steel was selected as a simple system that can be used to model tool steel, yet be applicable to a broader range of steel-copper applications.

The compositional cracking range of copper in AISI 1013 steel was found by fabricating a series of copper bead on steel plate welds of varying copper compositions by use of a Gas Tungsten Arc Welder with cold wire feed. The samples were sectioned, ground and polished using standard metallographic techniques, then etched in 2% Nital. Quantitative Image Analysis (QIA) and light optical microscopy were used to determine the compositional cracking range of copper in steel. Additionally, QIA was used to identify the appropriate solidification model; a modified “Scheil” condition. This combined information will be used in the future fabrication of functionally graded steel-Cu dies using direct metal deposition technology.

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