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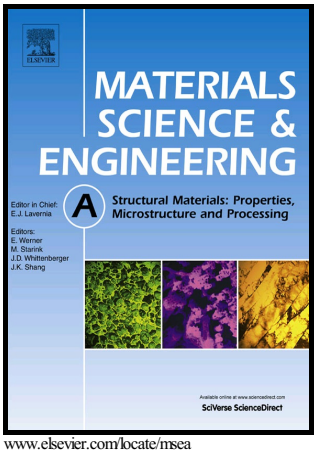
David A. College, Yuntian Zhu



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Alleviating surface tensile stress in e-beam treated tool steels by cryogenic treatment

David A. College [a,b], Yuntian Zhu [b]

[a] TE Connectivity, Harrisburg, PA 17105-3608, USA
[b] Department of Materials Science and Engineering, North Carolina State University, Raleigh, NC 27695, USA

ABSTRACT

Electron beam (e-beam) treatment of tool steel surfaces has been available for several decades as an approach to create hard surface layers on tool steels. The e-beam process produces ultrafine grain sizes through ultra-rapid cooling of the melt layer, which helps with improving wear resistance to increase the service life of tools. However, its implementation in many applications has been limited by the accompanying residual tensile stresses in the surface layer, which is undesirable and may lead to premature fracture. Here we report the utilization of cryogenic freezing after e-beam treatment to reduce the residual tensile stress. The e-beamed specimen contained high levels of retained austenite in the surface layer. The cryogenic treatment converted the retained austenite into martensite, and the corresponding volume expansion reduced the peak tensile residual stress by 28%, which makes it a promising method to expand the applications of e-beamed tool steel.

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KEYWORDS: Electron beam treatment, tool steel, residual tensile stress, cryogenic freezing, nanoindentation, X-ray diffraction

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