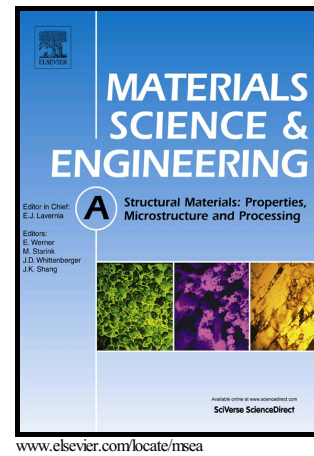


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Cryogenic temperature toughening and strengthening due to gradient phase structure

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Abstract

Cold embrittlement is one of the primary concerns challenging the usage of steels in infrastructures like pipelines and ocean platforms. This challenge is also compounded by the limited selection of materials for application in a cold and corrosive environment. Inspired by recent progresses in developing gradient structured materials with extraordinary properties, here we report a class of stainless steels with gradient phase structures achieving a superb combination of strength (1753MPa) and tensile ductility (>25%) at the cryogenic temperature of 77K. A set of cylindrical steel samples acquire a graded mixture of hard martensitic and soft austenitic phases through pre-torsion, which results in an optimal stress partition in the material - the hard martensitic structures showing a positive density gradient from core to edge carry higher stress near the edge, while the soft austenitic phase showing a negative density gradient from core to edge serves to retain substantial

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