Functionally Graded Material in a Ni-Based Superalloy Single Crystal

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ABSTRACT

In the present work, a novel manufacturing technique utilizing a differential stress aging treatment is devised to prepare functionally graded material (FGM) in a Ni-based superalloy single crystal CMSX-2. Standard aging without any applied stress produces cuboidal γ′-precipitates in the γ-matrix, whereas, aging with uniaxial stress produces rod-shaped or plate-shaped precipitates depending upon whether the stress is compressive or tensile and also the misfit present in the γ-γ′ microstructure. This effect can be utilized to produce a graded microstructure (composition remaining same) through a variable axial stress varying from tensile at one end to compressive at the other. Such a loading across the cross section of the specimen is achieved by loading the specimen under 3-point bending. A maximum tensile and compressive stress of 100 MPa is applied on the specimen placed on a 3-point bending fixture and kept inside a high temperature Instron machine at an aging temperature of 850°C for 20 hours. The feasibility of this new concept is supported by the results of SEM and TEM investigations, which show a continuous change in precipitate morphology from rod shaped to cuboidal and then to plate shaped across the cross-section of the specimen.

Keywords: Functionally graded material, Ni-based superalloy single crystal, differential stress aging and microstructural gradient

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