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Residual stresses in polycrystals as influenced by grain shape and texture. (English)

Zbl 0792.73069

J. Mech. Phys. Solids 41, No. 12, 1955-1977 (1993).

Summary: Residual stresses in polycrystals arise because of anisotropic thermal expansion of constituent crystals. Due to the random crystal arrangement, the internal stresses also become random quantities, which have to be described by probability distributions or statistical moments. Conditional first order moments (averages) and second order moments (fluctuations) can be derived if the elastic energy stored in the residual stress field is known. By applying the Green function method, an analytical expression for this energy is obtained under some mild assumptions concerning the neglected elastic anisotropy and crystallographic correlations between the crystals. From the stored energy we calculate the average crystal stresses as depending on shape, orientation and polycrystalline texture. Furthermore we obtain a scalar second order moment of the residual stress, which also depends on grain shape and texture. The results are evaluated for alumina ceramics and zircalloy.

MSC:

74A60 Micromechanical theories
74M25 Micromechanics of solids
74A40 Random materials and composite materials
74A15 Thermodynamics in solid mechanics
74S30 Other numerical methods in solid mechanics (MSC2010)

Keywords:

averages; fluctuations; anisotropic thermal expansion; random crystal arrangement; internal stresses; elastic energy; Green function method; scalar second order moment; alumina ceramics; zircalloy

Full Text: DOI

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