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Micromechanics for Multiple Inclusion Problems

Seiichi Nomura[1]

[1] Mechanical and Aerospace Engineering Department, University of Texas at Arlington, Arlington, TX 76019, USA, nomura@uta.edu

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An analytical approach is presented to obtain the thermo-mechanical fields in a body that contains multiple inclusions in a matrix phase. The exact thermo-mechanical field in 3-D is derived for a three-phase inclusion problem where a spherical inclusion coated by another layer is embedded in an infinitely extended matrix phase subject to both a constant far-field stress and heat flux at infinity. The steady-state temperature distribution is obtained first and based on the temperature field, the stress field is solved exactly by solving the differential equation after imposing the condition that the displacement and surface traction force are continuous at the inclusion-matrix interface. The analytical solution is made possible through the use of a computer algebra system without which it is impossible to carry out necessary algebra involved. It is also possible to apply the method to any number of multiple-phase composites although the amount of actual algebra would be formidably prohibitive. For 2-D problems, the Airy stress function is shown to be useful for a similar problem having a circular inclusion coated by multiple layers. Once the exact solution for a single inclusion is obtained, it is possible to obtain the effective properties for multi-inclusion problems by one of many methods developed in the past fifty years such as the Tanaka-Mori approach.

REFERENCES

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