ADAPTIVE VOLUME FRACTION DESIGN FOR THERMAL STRESS REDUCTION IN FUNCTIONALLY GRADED MATERIALS

J.R. Cho[a] and **H.J. Park**

[a]School of Mechanical Engineering
Pusan National University
Kumjung-Ku, Busan 609-735, Korea
jrcho@hyowon.pusan.ac.kr

In the volume fraction optimization for FGMs, both thermoelastic and volume fraction fields are usually discretized with finite elements. Then, the mesh density becomes a key parameter determining the final design quality, so one may need to refine the initial mesh when further reduction in the objective function would be desired. Meanwhile, the design variable number increases in proportional to the element number in the volume fraction mesh, and which results in the CPU-time increase, particularly when finite difference scheme is employed for the design sensitivity analysis.

For this reason, the non-uniform refinement of the initially coarse volume fraction mesh only where more flexible volume fraction distribution is required, while using the relatively fine thermoelastic-field mesh, would be preferable from the computation point of view. This local non-uniform refinement of mesh density can be implemented by the irregular *h*-refinement. Its basic concept is to minimize the element number, for the preset numerical accuracy tolerance, by refining the elements showing relatively high gradients in the solution field. This concept can be extended to the volume fraction optimization by considering the objective function as the solution field.

The major purpose of this study is to explore the applicability of the adaptive h-refinement scheme to the volume fraction optimization for the thermal stress reduction in heat-resisting FGMs. As well, the scaled linear combination of the peak effective stress and the total strain energy is examined as an appropriate objective function for the current optimization problem. In fact, the objective function in the $L^{\infty}-$norm sense may frequently encounter the numerical optimization failure, for general two- or three-dimensional cases, owing to the possibility that the critical value reaches simultaneously in at least two distinct points.

References

[1] J.R. Cho and H.J. Park, "Effective Volume-Fraction Optimization for Thermal Stress Reduction in FGMs utilizing Irregular *h*-Refinement," *International Journal for Numerical Methods in Engineering*, in press.
[2] J.R. Cho and D.Y. Ha, "Optimal Tailoring of 2D Volume Fraction Distributions for Heat-Resisting Functionally Graded Materials using FDM," *Computer Methods in Applied Mechanics and Engineering*, v. 191, p. 3195-3211, 2002.
[3] J.T. Oden and J.R. Cho, "Adaptive *hpq*-Finite Element Methods of Hierarchical Models for Plate- and Shell-Like Structures," *Computer Methods in Applied Mechanics and Engineering*, v. 136, p. 317-345, 1996.
[4] J.M. Guedes and N. Kikuchi, "Preprocessing and Postprocessing for Materials Based on The Homogenization Method with Adaptive Finite Element Methods," *Computer Methods in Applied Mechanics and Engineering*, v. 83, p. 143-198, 1990.