“Fracture Mechanics of NiTi Shape Memory Alloys”

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Abstract
Experimental and numerical works on Shape Memory Alloys (SMAs) are numerous, but more studies on fracture mechanics of SMAs are still needed. In the case of cracked SMAs, phase transformation around crack tip occurs almost immediately, and thermomechanical coupling, dissipation and nonhomogeneity that occur, renders the use of classical equations very difficult.

In this talk, experimental, analytical and computational works on the effect of phase transformation on fracture parameters of a superelastic Nitinol are presented. First, the asymptotic equations of LEFM, the J integral, and the stress intensity factor are introduced; then, the complexities added with phase transformation are discussed. Experiments are conducted with edge cracked thin Nitinol plates, and the critical stress intensity factor (Kmax) is determined. The displacement field around the crack tip is obtained and the transformation zone is characterized using Digital Image Correlation (DIC) data. Some samples are tested at T=100° C to suppress the martensitic transformation to investigate the effect of transformation on toughening. The effect of loading rate is observed from testing edge cracked NiTi samples, and evaluating Stress Intensity Factors using DIC and E399. An interesting behavior in Kmax values vs loading rate is seen.

The equation governing the stress-induced phase transformation is obtained in closed form using the asymptotic equations of Hutchinson and LEFM; the change in the size of transformation zone is evaluated; the results are plotted and compared to experimental ones. Using finite elements, and two different constitutive models, fracture parameters such as J-integral, energy release rates, COD and stress-intensity factors, and the phase transformation zone are evaluated computationally. The contour dependence of J Integral is shown and discussed.

Biography
Prof. Anlas is the Dean of Engineering at Bogazici University in Istanbul, Turkey. He received his Ph.D. in Mechanical Engineering from the University of Delaware in 1992. He has been working as a faculty member at Bogazici since 1992. He is the founder of the Automotive Engineering Program at Bogazici University. His current research interests are in the area of fracture mechanics of shape memory alloys and renewable energy technologies. He is conducting joint research on SMAs (shape memory alloys) with students and colleagues from NWPU in Xian, China, and from ENSTA Paris Tech (France).

Faculty, students, and the general public are invited.