A NEW APPROACH TO EVALUATE RESIDUAL STRESS USING INSTRUMENTED INDENTATION TESTING AT NANO SCALE

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In structural integrity, residual stress is one of the major factors affecting structure failure. In particular, tensile residual stress accelerates crack growth and reduces integrity. Hence test methods have been devised that can quantitatively evaluate residual stresses, including X-ray diffraction, hole-drilling, and contour methods. Now a relatively new technique, instrumented indentation testing, can be used to quantitatively evaluate the surface residual stress of a structure semi-nondestructively with mechanical response causing small indents. Many studies have confirmed that indentation load-displacement curves are shifted depending on the residual stress state. For the same indentation depth, a larger indentation load is required for a compressive residual stress state, and a smaller indentation load is required for a tensile residual stress state, in contrast to the stress-free state. Thus, for the same indentation depth, there is a difference in indentation load between the stressed and stress-free states. Kwon and Lee have suggested and verified experimentally that, among the surface residual stress components, a deviatoric stress term parallel to the indentation axis induces a virtual force that affects the plastic deformation occurring during indentation, and consequently also affects the indentation load-displacement curve. [1] In this paper, principle and application for measuring residual stress by IIT at multi-scale will be included.

References

[1] Y.-H. Lee and D. Kwon, “Estimation of biaxial surface stress by instrumented indentation with sharp indenters”, Acta Materialia 52. 1555-1563, 2004.