

ACCOUNTING FOR RESIDUAL STRESS IN INTEGRITY ASSESSMENT OF 3-D STRUCTURE

R. J. Bucci, M. A. James
Alcoa Technical Center

D. L. Ball
Lockheed Martin Aeronautics Co.

The quest for lighter and more affordable airframes has accelerated demand for thicker/wider/shaped alloy products (plate, extrusions, forgings, castings) and manufacturing technologies (e.g., high-speed machining, weld-joining) to grow applications of unitized structure. Capturing the full benefit of these technologies requires that residual stress effects be accounted for in both material characterization and final part design. In the case of thick or shaped metallic products, residual stresses from thermo-mechanical processing can introduce bias and large scatter effects into coupon-based durability and damage tolerance property determinations, which in turn confounds the ensuing transfer to final design.

The presentation will describe efforts of Alcoa and others directed to developing improved fatigue crack growth rate data analysis methods and modeling tools that may be used to account for residual stress effects in testing and analysis. Two fundamental principles will be discussed at this seminar: advancements in fracture toughness and fatigue crack growth rate testing and analysis; and the way forward to account for the residual stress effect(s) in analysis and design of fatigue and fracture critical structures. Case study examples are presented to validate the recommended approach, and the presentation concludes with a vision for virtual design support to large monolithic part applications.