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Post-mortem Microstructural Observations of Spall Processes

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Spall in ductile metals is a mode of dynamic tensile failure caused by the nucleation, growth, and coalescence of voids. In general, laser interferometric measurements of the free surface velocity are recorded and the spall strength is inferred from the pull back velocity. Recent results have shown the strong role of the microstructure on the resistance of a material to spallation. The spall pullback signals clearly indicate the influence of the spatial density of intercrystalline defects such as grain boundaries and triple junctions in comparison with the work-hardening characteristics that are more dominant in the single crystal samples. However, complementary microstructural analyses of recovered samples to further elucidate the role of grain boundary crystallography and elastic anisotropy on the nucleation and growth process are only now starting to attain a more prominent place as recovery techniques become more robust and commonplace. Of particular note is the emergence of SEM-based electron backscatter diffraction microscopy to complement transmission electron and optical microscopy observations. The technique affords a wide and statistically significant spectrum of spatial and angular information that would enable the development of more physics-based failure models. Observations of spall behavior, particularly crystallography around the voids will be presented. This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.