Directional Dependency of Bulk Fracture Toughness in Cold-Sprayed Al 6061 Deposits

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Abstract

Cold spray additive manufacturing is of interest in the repair of aerospace and other specialized materials, where high-temperature processes are either undesirable or infeasible. However, the use of cold spray to produce structural components and repairs requires knowledge of the load-bearing capacity of cold spray deposits, such as tensile, fracture, and fatigue properties. In this work, we study the critical fracture toughness of cold spray deposits which has, thus far, received limited attention in the literature. We perform fracture tests on aluminum (Al) 6061 deposits, sprayed with helium, in six different crack orientations, and we examine the directional dependency of the fracture toughness. We find only a limited amount of anisotropy in the deposits, and that the fracture toughness is approximately 40 – 50% that of wrought Al 6061-T6 material. Fracture occurs predominantly as particle-particle decohesion (inter-particular fracture), although there is some fracture through particles (trans-particular fracture), as well. The relative amounts of inter- and -trans-particular fracture depend upon the crack orientation in the deposit and correlate with the fracture toughness. Overall, the results contribute to a basis for understanding the resistance to failure that might be expected of cold spray deposits operating under critical fracture service loads in structural applications.