Enhanced performance of aluminum based structures exploiting liquid-solid interfaces

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Abstract:

Two examples of liquid-solid interfaces will be detailed including their design strategy and characterization. The resulting mechanical properties (strength, ductility, toughness and fatigue life) will be associated to the underlying microstructural features. The presentation will establish the status of the understanding of these phenomena exploiting experimental tools.

1. A new high strength healable Al alloy manufactured by metal powder 3D printing (Laser Powder Bed Fusion - LPBF) [1] is designed to present a healing capacity in addition to high strength. The healing concept uses a heat treatement with or without the application of a pressure above the eutectic temperature of the alloy to locally melt the alloy and thus heal the voids due to the process or due to damage (associated to overloading), Figure 1. The healing is also associated to solid-state diffusion of fast-diffusing atoms, such as magnesium in aluminum [2]. In addition, this healing concept leads to exceptional fatigue life of the part after healing.
2. A dissimilar welding process, patented at UCLouvain, called Friction Melt Bonding [3-9], involves the local melting of a low melting point alloy (typically aluminum) to join it to a high melting point alloy (typically steel or titanium), Figure 2. The formation of the joint is insured by the formation of an intermetallic at the interface between both alloys and its composition is modified to lead to enhanced fracture toughness.

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Figures:

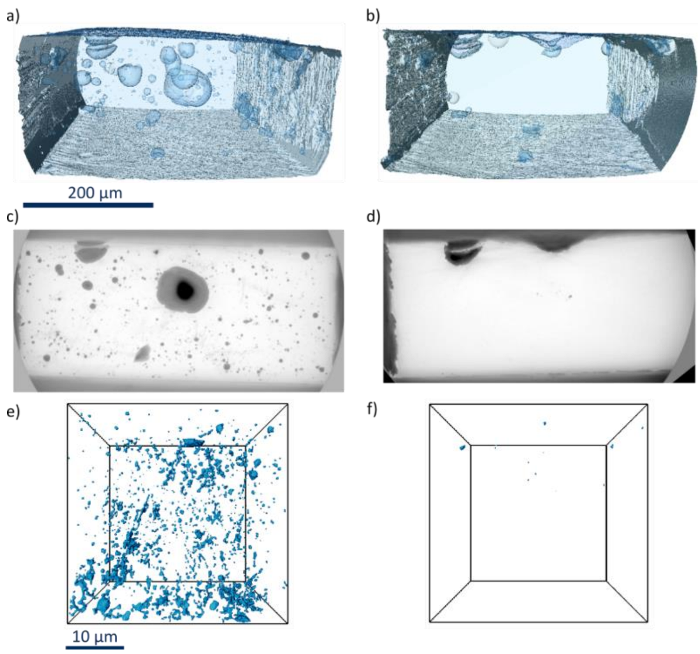

Figure 1: Reconstructed volume of the full sample obtained by X-ray nano-Computed tomography a) before and b) after healing (pressure and temperature of 540°C) with a voxel size of 200 nm. Minimum intensity projection along z for the first 44 µm of the reconstructed volumes presented above c) before and d) after healing. 3D rendering of the voids (in blue) with a voxel size of 35 nm e) before and f) after healing. From [1].

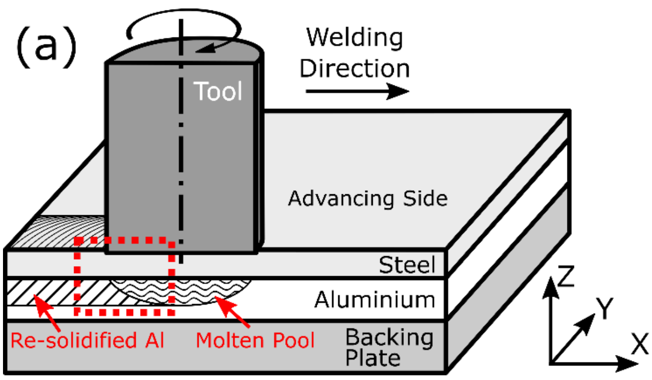

Figure 2: Schematic cut in the longitudinal direction of the FMB process. From [5].