Friction Stir Spot Welding between Porous TC4 Titanium alloy and Ultra High Molecular Weight Polyethylene

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Abstract

Joining of polymer to metal has caused extensive concern due to its advantage of great weight reduction and excellent integrated physical/chemical properties. High quality metal-polymer hybrid structures have been increasingly needed in automotive, aerospace and biomedical industries. In this study, the biomedical additive manufactured porous TC4 titanium alloy plate was successfully joined with ultra-high molecular weight polyethylene (UHMWPE) plate by friction stir spot welding (FSpW). Welding temperature (T_w) at TC4/UHMWPE interface and the z-axial force (F_z) during welding has been measured and found to have a strong relationship. The arch-shaped welding interface, featured by the embedment of UHMWPE into porous TC4, formed under the synergistic effect of strong F_z and unevenly distributed T_w at the interface, which contributed to the strong macro-mechanical interlocking. Also, relatively good interfacial bonding between TC4 and UHMWPE has been observed. Meanwhile, different 3D structure of porous TC4 alloy has been adopted for the purpose of improving the joint strength. High ultimate lap shear tensile strength has been obtained by forming a large macro embedded zone and good micro interlocking between TC4/UHMWPE with optimized parameters during FSpW.

Keywords: Friction stir spot welding; Metal-plastic joining; Additive manufacturing; Porous structure