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In Situ Investigation into Temperature Evolution and Heat Generation during Additive Friction Stir Deposition: A Comparative Study of Cu and Al-Mg-Si

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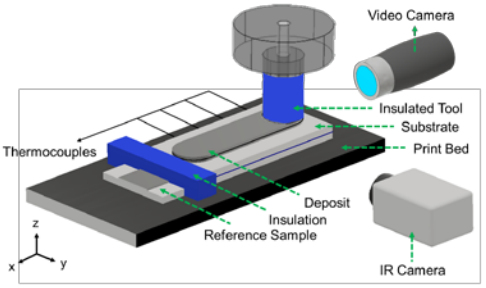
Abstract

Additive friction stir deposition (AFSD) is an emerging solid-state additive manufacturing technique that enables site-specific build-up of high quality metal with fine equiaxed microstructures and excellent mechanical properties. Still early in its development, a thorough understanding of the thermal features during AFSD including temperature evolution and heat generation mechanisms has yet to be established, which limits the control of the microstructure and properties of the as-printed material. Here, we investigate the thermal features of AFSD through *in situ* monitoring of the temperature evolution and material deformation flow, with a comparison between Cu and an Al-Mg-Si alloy. By analyzing the thermal characteristics under a range of processing conditions, we have found generic trends of peak temperature T_{peak}, exposure time, and cooling rate with respect to the key processing parameters such as tool rotation rate $\boldsymbol{\Omega}$ and in-plane velocity $\boldsymbol{V}$ in both materials.



An illustration showing in process monitoring of temperature and material flow for additive friction stir deposition

Biography

David Garcia earned his B.S. in Materials Science and Engineering from Virginia Tech in 2012. He continued as a direct PhD Candidate in Dr. Hang Yu's research group and is expected to defend in Fall 2020. He has experience in many facets of additive manufacturing that include modelling, process monitoring, and multi-material design. David's current work involves in situ characterization of the thermal and thermo-mechanical histories of several material systems processed by additive friction stir deposition to understand the relationship between processing parameters, processing history, and as-deposited microstructure for the developing technology.