Extending Additive Manufacturing to the Atomic Scale Focus Topic

Room Hall B - Session AM-TuP

Extending Additive Manufacturing to the Atomic Scale Poster Session

AM-TuP2 Laser Induced Formation of Eutectic Nanostructures in Al-Cu Powder for Additive Manufacturing, ***Jonathan Skelton***, *C.V. Headley, J.A. Floro, J.M. Fitz-Gerald,* University of Virginia

With the emergence of additive manufacturing (AM) via laser powder bed sintering, design of the starting powders represents a critical area of interest, dictating the final properties of the AM components a large degree. The ability to design the nanoscale physical structure within powder particles in order to improve the final properties (optical, mechanical, thermal) remains a challenge. This research investigates the change in the eutectic microstructure of Al-Cu powders following laser irradiation. The initial powder alloy (gas atomized, Al-33wt%Cu) exhibited a variety of eutectic microstructures due to the varying solidification rates of particles within the gas atomized process. As-received powder was annealed at 450°C for 2 hours so as to create a uniform, $Al+Al_2Cu$ two-phase structure with an interphase periodicity of about 2 µm. The original lamellar eutectic is broken down into a more irregular structure as part of the coarsening process. The powder, mounted on a glass slide and within an air ambient, is then subject to pulsed laser irradiation (wavelength = 248 nm, pulse duration 25 ns, fluence of 1.5 J/cm^2). Irradiation melted the particles, creating a new eutectic solidification structure with lamellar morphology. The interphase spacing was reduced to 30 nm, indicative of rapid solidification. Due to the lack of wetting or sintering between particles, it was concluded that each particle was melting and solidifying within its respective oxide shell. Though particles retain a largely spherical shape, many particles displayed a collapsed or partially “deflated” morphology after laser irradiation. The origin of the deformed morphology is not understood, but does not appear to be a phenomenon strictly associated with an instability imposed by the pulsed irradiation. It is suspected that the rapid growth and deflation of the oxide shell due to the thermal expansion of the Al-Cu particles may play a role. Samples were characterized by scanning electron microscopy (SEM), dual beam focused ion beam (DB FIB), and x-ray photoelectron spectroscopy (XPS). Support of the National Science Foundation through grants CMMI-1663085 is gratefully acknowledged.

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