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Synthesis of Nanoscale Metal Feedstock with Low-Temperature Sinterability for 3D Printing

-Background Nanoparticle-based metallic powders are of interest for rapid sintering, thermal bonding, and electrically conductive metal pastes due to its unique properties, such as lower sintering temperature compared to bulk counterparts and efficient light absorption for photonic curing. However, there are some drawbacks associated with the production, handling, and storage of nanoparticle-based metallic powders, such as high reactivity and flammability, poor flowability due to excessive agglomeration, and high production costs associated with scaling the production of nanoparticles. Invention Description Researchers at Arizona State University have developed mesoporous gas atomized metal (MGAM) powders synthesized by a chemical dealloying technique with sub-100nm ligament sizes. This ligament size confers low-temperature sinterability characteristics and allows welding at a third of the melting temperature via solid state welding processes such as thermal sintering and ultrasonic-based near-room-temperature welding. With these low-temperature sintering characteristics, MGAM powders permit extruding, printing, casting, sintering, and consolidating of the feedstock at sub-400°C temperatures, meaning that metals such as copper (with a melting point of 1000-1100°C) can be concomitantly printed with polymers whose degradation temperatures are above 400°C. After sintering, the metal is electrically conductive and solid, and thus suitable for the manufacture of embedded circuits. Potential Applications •   3D printing •   Metal powder casting •   Injection molding •   Embedded circuit fabrication Benefits and Advantages •   Low-temperature sinterability allows 3D printing of metals at temperatures that will not jeopardize polymer integrity •   High flowability and dispersibility •   Enables objects that are 3D printed via fused deposition modeling (FDM) to retain shape during sintering •   Compatible with methods such as powder bed fusion, directed energy deposition, and binder jetting •   Yields polymer matrix composite filaments with high packing factor of metals (>60%) •   MGAM powders can absorb light up to 200% more efficiently than solid counterparts and reduce reflected power in powder bed fusion processes and directed energy deposition Faculty Homepage of Professor Bruno AzeredoResearch Homepage of Professor Kenan Song