Title: Printed Conductive Traces for High Power Applications by Reaction-Assisted Sintering

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Abstract

We present a new paradigm for sintering conductive traces from a printed ink. Today's conductive ink market is dominated by inks based on silver nanoparticles that can be sintered into conductive traces by annealing at 150-200 °C for 2 hours. For certain applications, such as those requiring high currents or high temperatures, these silver-based inks are susceptible to thermally-mediated failure, such as electromigration or interdiffusion.

At Draper we are developing a new type of conductive ink that, once sintered, exhibits high temperature stability. These inks are composed of composite metal particles in a liquid carrier matrix. The composite metal particles are ball-milled particles with stored chemical energy that is released during sintering in an Intense Pulsed Light (IPL). The IPL sintering has several advantages over the thermal anneal used for nanoparticle silver inks. Firstly, the IPL's short time (3 ms) and high energy (8 J/cm^2) initiate an exothermic reaction in the metal particles, and the consequent energy release contributes to local heating and sintering of the metal particles into a continuous line. We have termed this effect, "reaction assisted sintering". Secondly, the result of this reaction is a more stable material, with low susceptibility to electromigration and diffusion-related failures. Finally, the short time and inherently surface heating of IPL limits the temperature profile experienced by the substrate, and we have printed and sintered our inks on Kapton, silicon, silica, and alumina substrates.

We will further describe the composite metal particles, the ink formulations, and our characterization of the conductive traces.

Short Bio: Sara Barron is a materials engineer at Draper with an expertise in inorganic, reactive, and thin film materials. Prior to Draper, she worked at the National Institute of Standards and Technology (NIST) and Johns Hopkins University and earned degrees in Materials Science and Engineering from Cornell University (PhD) and MIT (BS).