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Rheological Behavior of Silver Nanowire Screen Printable Conductive Ink

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Screen printing is a rapid and economical technology for the fabrication of current collectors on solar voltaic panels. With growing demand for these devices, there is much interest in the use of silver nanoparticles to produce inks of high conductivity and low sintering temperatures. This work, undertaken by an academic-industrial collaboration, is directed to screen-printable inks formulated with silver nanowires in high concentration. Silver nanowires offer the conductivity and sintering advantages of nanoparticles as well as desirable rheological properties without the need for non-conductive rheological agents. These target properties are strong shear thinning behavior and rapid viscosity recovery after printing. Shear thinning permits loading and through-screen printing of ink with good uniformity, while rapid recovery assures good line-edge definition in the printed circuit. Shear thinning is a consequence of particle alignment and disentanglement at high shear, whereas viscosity recovery is a result of diffusive randomizing of particle arrangements during build-up of the ink structure after the applied shear is removed. Silver nanowires synthesized by the polyol process were used to formulate aqueous inks at various particle loadings. The dynamic rheological behaviors of the inks were evaluated with a parallel plate rheometer. The viscoelastic behavior of the inks due to particle alignment and interactions at high loading was assessed broadly by shear-sweep methods and under conditions relevant to screen printing by a peak-hold method. The dependence of recovery time on particle loading, temperature and Peclet number was evaluated. The recovery time was compared with the stretched exponential model already established in the literature.

Keywords: Silver Nanowires, Screen Printing, Nano-Suspension Rheology