On the Behavior of Ink-Jet Printed Nano Silver Traces on Porous PET Substrates in Cyclic Loading

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Abstract

Low cycle fatigue testing of ink-jet printed nano-Ag traces on porous PET substrates revealed an unusual behavior, the resistance ***dropping*** in cycling. The resistance would in fact increase as the substrates were stretched, and decrease again during unloading, but the resistances both at the peak strain and zero would each drop in consecutive cycles. This effect was stronger for higher strain amplitudes, but it was reduced or eliminated by preceding annealing of the samples.

The present work addresses mechanical and reliability characteristics of a Silver nanoparticle ink (Novacentrix Metalon® JS-B25HV) printed onto porous PET substrates with different roughnesses using ink-jet printing technology (FUJIFILM Dimatix-2831). Interconnects of an average width of 80 µm and two different average thicknesses (500 nm single-layer and 700 nm double-layer) were considered. Samples were subjected to different combinations of annealing and thermal cycling followed by fatigue cycling in tension and bending using an Instron-3344 tensile tester at different strain amplitudes (1.00%, 1.50% and 2.00%). The electrical resistance of each sample was monitored *in-situ* by four-point measurement.

Contact angle measurements of drops of deionized water were conducted to evaluate the roughnesses of the substrate surfaces and correlated with the test results. The change in relative resistance is faster in single layer than in double layer traces for the same strain amplitude. Cross-sections of the substrate showed pores of width ~40nm which provide good adhesion of the nano-particle ink to the substrate. We suggest that organic material infiltrating into the pores during cycling leads to a concentration of the remaining Ag on the surface and thus increasingly better connections.