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Mechanical durability of screen-printed flexible silver traces for wearable devices

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Abstract

There is increased usage of flexible electronics recently in various applications such as wearable devices, flexible displays and sensors. Studies on the durability of conductive metal traces under cyclic mechanical loading is crucial since these conductors will be subjected to repeated bending. In this work, the mechanical and electrical behavior of silver printed conductors was tested using cyclic three-point bend test. The samples were flexible polymer thick film (PTF) silver (Ag) ink printed on a flexible polyethylene terephthalate (PET) substrate. The durability of this PTF Ag ink, which has a hyper-elastic binder and Ag flakes, was studied by performing cyclic bending tests. Four-point resistivity measurements and imaging of the sample both before and after bending were performed. A custom tester machine was used to apply strain to the circuit and measure the resistivity of the silver trace. The results of the bending test show that the silver trace does not undergo significant deformation and the change in resistance is less than 0.6% under both tensile and compressive tests. Fatigue tests were also performed by cyclic bending tests for three trials in which batches of 10,000 cycles were completed. The printed silver wire withstood 30,000 cycles of bend tests and produced only 2.64% change in resistance. This indicates that the printed wires are very durable even after 30,000 cycles of outer bending. Imaging was also conducted on these samples to study the effect of repeated bending on the morphology of the silver conductive trace. Although there was an increase in surface roughness before and after cyclic bending, there was no obvious deformation or delamination observed in the samples.

Author Keywords

Bending test; Flexible electronics; Mechanical durability; PTF silver ink; Screen-printed

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