Evaluation of a Novel Anisotropic Conductive Epoxy for Integration of Stretchable Wearable Electronics

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Abstract:
Stretchable wearable electronics often require the integration of mechanically different materials to fabricate functional devices that are flexible, stretchable, conformal, and sufficiently reliable. Common methods to integrate highly stretchable conductors with other Flexible Hybrid Electronics (FHE) components such as flexible substrates, E-textile, and surface mount devices include solder and isotropic/anisotropic conductive adhesives or films. However, these methods have been primarily demonstrated with printed solid metal conductors such as silver, copper, gold, or carbon materials. Due to the nature of the stretchable conductors, each of those methods has its own limitations or drawbacks for soft/much softer, rigid/soft assemblies for wearable, stretchable devices. ZTACH® ACE, a magnetically aligned Anisotropic Conductive Epoxy developed by SunRay Scientific, has promising potential for such integration due to its excellent adhesion to most substrates of interest, low curing temperature, and no pressure processing requirements.

This study investigates the effect of the mechanical and environmental stresses on ZTACH® ACE bonding between SMD resistor/e-textile components to e-textile, Cu-Flex PCB/e-textile/SMD resistor components to Polymerized liquid metal network through vias or direct contact, and e-textile to electronic module board (rigid and flex). The test coupons were subjected to various mechanical and environmental stresses through tensile test, shear test, fatigue cycling for over high number of cycles with high strain amplitude, and exposure to temperature and humidity conditions.

The results showed that the ZTACH® ACE exhibited good adhesion and low contact resistance and robustness during electromechanical testing. In addition, the Poly-LMN to e-textile or Cu-Flex assembly through ZTACH® ACE showed no noticeable increase in the electrical resistance from cycle to cycle during fatigue cycling. Also, the environmental conditions showed no significant impact on direct contact joints; however, there was a permanent failure to via connections due to moisture absorption, which led to cracks/delamination.

Keywords: Stretchable Electronics, Anisotropic Conductive Epoxy, Polymerized Liquid Metal, Wearable Devices.