Surface Resistivity Study of two E-Textiles in Harsh Environments

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Wireless body area networks (WBAN) have been a trending topic in recent years because of their important applications in military, sports and wellness industries. E-textile antennas and circuits show great potential to implement WBANs due to their low mass, physical flexibility and ease of integration with garments. Many techniques and materials have been attempted to realize e-textiles. One common approach is the embroidery of metal-coated conductive threads on ordinary textiles/fabrics [Wang, *IEEE Trans. Antennas Propag*. vol. 60, pp. 4141-4147, 2012]. However, some of the metal-coated conductive threads are simply too fragile (leading to thread breakage) for use in standard embroidery machines. E-textiles can also be constructed by depositing a conductive metal layer on top of a fabric by conductive ink printing [Parashkov, *IEEE Proc.* 2005] or metal coating [Yan, *IEEE Trans. Antennas Propag.* vol. 63, pp. 4640-4647, 2015]. These approaches can provide excellent isotropic conductivity, and the end result has a much thinner profile compared to the embroidered option. Several studies have been conducted that investigated the resistivity and RF performance of different e-textiles under normal conditions. However, few investigations exist that consider the resistivity change when e-textiles undergo different environmental conditions, wear, and refurbishment.

To measure the e-textile performance under these stressors, we tested the surface resistivity of two metal-coated fabrics before and after various treatments. One woven fabric and one knitted fabric were chosen: nickel-copper-coated nylon ripstop fabric and silver-coated cotton/polyester jersey fabric. Performance measures included abrasion, perspiration, pilling, moisture, temperature, wrinkling, and laundering with various detergents. AATCC and ASTM standard textile test procedures formed the basis for all testing. Surface resistivity was measured based on the AATCC 76 Test Method [AATCC Technical Manual]. Fabric specimens were cut into 2x2 inch squares. Two copper electrodes were placed on opposite edges of the specimen, and the resistivity was recorded using a Fluke 298 multimeter. The surface resistivity was measured in both warp and filling yarn directions of the e-textile fabric.

After surface resistivity testing, RF performance was also investigated. Firstly, two microstrip antennas were fabricated using these two e-textile fabrics. A vector network analyzer then measured reflection coefficients, resonant frequencies and gains. Then 50 Ohm microstrip transmission lines was fabricated by the two fabrics and the insertion loss was measured. Finally, comparison were made between e-textile antennas/transmission lines and traditional copper microstrip antennas/transmission lines.