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HOW HUMIDITY AFFECTS TEXTILE ANTENNA PERFORMANCE

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Abstract: The trend to integrate more and more functionality into our garments has led to the development of wearable textile systems. With that, the necessity for integrable wireless communication systems was revealed. Antennas made entirely out of integrable textile materials have been the subject of research for several years now. Microstrip patch antennas (MPA, Fig. 1) operating in the 2.45 GHz ISM (Industrial, Scientific, and Medical) band are most appropriate for integration into clothing because of their low profile and planar structure. These antennas consist of an antenna substrate, which is a nonconductive material, with an antenna patch on top and a ground plane on the back. The patch and ground plane are manufactured using electroconductive (copper plated) textile material, also referred to as e-textiles. However, when integrated into clothing, textile antennas are subjected to environmental changes. Humidity is the parameter to be most considered because moisture alters the electromagnetic properties of the substrate material. As textile structures contain many air cavities, their relative permittivity (εr) is generally situated between 1 and 2, whereas water, with εr = 78 and tanδ = 0.15 at 2.45 GHz at 25°C, has a much higher dielectric constant. This paper reports on the research performed on five carefully selected textile materials with various moisture regain properties, applied as antenna substrate. These materials are character-ized and antennas are designed with these materials as antenna substrate. Then, the textile antenna characteristics are compared in a variation of humidity conditions. A quadratic correlation was found between the relative permittivity of the antenna substrate material and relative humidity of the environment in which the antenna operates. Additionally, the quadratic coefficient is linearly related to the moisture regain of the substrate. This relationship sums up our conclusion that materials with a smaller moisture regain are considerably less vulnerable to changes in electromagnetic characteristics and are therefore the obvious choice for designing textile antennas.