A Liquid-Metal-Embedded Stretchable Frequency Selective Surfaces for Wide-Band Tuning.

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Frequency selective surfaces (FSSs) have been widely used in modern communications and military applications for providing desirable filtering responses such as bandpass or bandstop responses. Some examples include radomes, EMC/EMI shielding, reflector arrays, and phase shifters. Various tuning techniques have been developed for switching or continuously tuning the frequency responses of FSSs such as liquids, plasma, electronics, magneto-materials, memory-alloy, and mechanical stretchable materials. Among these methods, the stretch-tunable approach attracts lots of attentions due to its high-power-handling capability and large-area tuning. For most electrode-coated stretchable FSSs, however, their frequency tuning ranges are limited because the coated electrodes tend to break and lost the conductivity under large deformations.

In this paper, we proposed a stretchable FSS composed of liquid metal embedded within a commercial-available stretchable polymers, Ecoflex. Ecoflex was a silicone-based polymers with large strain rate up to 900%. In order to achieve wide-band tuning, each unit cell was designed to have a bow-tie shape and embedded with metallic liquids. By applying external forces, the FSS deformed from the bow-tie shape to an approximately rectangular where the metallic liquid retained within the substrate and flew according to the deformed channels. The frequency responses deviated as the FSSs deformed. Compared to other stretchable FSSs, our proposed device had a compact size and wide tuning range. A prototype was designed, fabricated, and examined with waveguide tests. The detailed fabrication processes and design procedures will be will be presented and discussed at the symposium.