Thick Frequency Selective Surfaces for High Power Microwave Applications

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Frequency selective surfaces (FSSs) have been widely used in modern communications and military applications acting as spatial filters for providing desired frequency responses such as band-pass and band-stop responses. Wide examples include radomes, EMC/EMI shielding, reflector arrays, and phase shifters. Recently, with the emergency of metamaterials, there is a fast development of miniaturized FSSs with sub-wavelength unit cell for light weight, low profiles, and insensitivity of oblique incident angles. However, miniaturized metallic structures might cause intense concentrations of electrical fields leading to the occurrences of breakdown. In addition, thin FSSs are not suitable for some severe environments such as underwater or on the sea applications which salt can corrode the metallic layers. Therefore, the goal of this research is to develop a thick FSSs with high power capabilities for protecting military ship's radar systems on the sea.

In this research, we proposed a multi-layered design with thick substrate layers and a cross-slot FSS with high power compatibility and a band-pass response at X-band frequencies. To achieve those features, we exploited the technique of substrate integrated waveguide (SIW) to suppress unwanted low-frequency resonances. In contrast to conventional SIW utilizing metallic via holes, we used hollow via holes to suppress low frequency resonances. To reduce electric field concentrations, the edges of the cross-slot were chamfered with a radius of 13.5 mm. The frequency responses and high-power capability were examined via the full-wave EM simulations and circuit simulations. The detailed design procedures, and related theories will be presented and discussed at the symposium.