Active Reflection Phase Surfaces for Cognitive Radar

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Metamaterial and electromagnetic band gap (EBG) surfaces exhibit reflection phase characteristics that are different than perfect electric conducting surfaces. The reflection phase can contribute to enhancing the gain of an antenna placed on the top of such surface. It also contributes to changing the radar cross section of the object that is covered with the active surface. This characteristic may have applications in cognitive radar systems. It also has applications in radar jamming systems. The adaptive reflection phase off the active surface may be used to introduce false target information in high range resolution (HRR) radar and other high resolution imaging radar.

Electromagnetic band gap surfaces reflect the signals with a reflection phase of $\pm$135 degrees around the resonance frequency of the structure. The limit of the usable phase reflection may depend on the application. Methods of increasing the bandwidth include progressive EBG and stacked EBG designs that include multiple resonances, hence the broad bandwidth (Zaghloul, Palreddy, Weiss, EuCAP 2011; Palreddy, Zaghloul, Lee, EuCAP 2012). Dynamic adjustment of the parameters of the EBG structure would produce different resonance frequencies with correspondingly different phase responses over narrow bands.

Similarly, metamaterial surfaces composed of split ring resonators (SRR), or similar cell structures, produce reflection phases that are functions of the dimensions and the dielectric materials of the unit cell (Ourir, Burokur, de Lustrac, Electronics Letters, 2007; Hand, Cummer, J. Applied Physics, 2008). Imposing variable voltage biases can also change the capacitances in the SRR gaps, resulting in changing the resonance frequency and the reflection phase of the SRR surface.

This paper reviews different methods used to dynamically control the reflection phases of active metamaterial surfaces, including EBG structures. Their uses in cognitive radar and radar jamming systems are demonstrated.