All-dielectric frequency selective surfaces are a revolutionary new technology for controlling high power beams, providing stealth to HPM weapon platforms, and protecting platforms from HPM attack. We have demonstrated that these devices can not only survive and function in a high power environment, but they are safer to handle because they are all-dielectric and they are more mechanically robust than traditional frequency selective surfaces because they can be monolithic.

**PRINCIPLE OF OPERATION**

Our all-dielectric frequency selective surfaces are based on guided-mode resonance. The devices are both diffraction gratings and slab waveguides. When a beam is incident on the device, it is diffracted by the grating into a set of discrete modes. Under special phase matching conditions, a diffracted mode is coupled to a leaky mode in the slab and the device becomes highly reflective due to resonance. More commonly used in optical devices, guided-mode resonance devices had several problems at radio frequencies that were all overcome in this research. There were: (1) inability to function on curved and conformal surfaces, (2) large physical size due to requiring hundreds of grating periods to operate, and (3) prohibitively narrow band and narrow field-of-view.

**EXIGOUS NUMBER OF PERIODS**

We showed that a device with very few periods can perform like an infinitely periodic device by incorporating reflective terminations. Spacer regions were added to tune the round trip phase of a guided mode to be an integer multiple of $2\pi$.

**BROADBAND AND WIDE FOV**

“Hypergratings” were developed to enable the FSSs to be broadband and have a wide field-of-view. This was accomplished by simultaneously engineering the diffraction and dispersion of the device. The geometry of the devices were optimized using particle swarm optimization.

**HIGH POWER TESTING**

Devices were tested for survivability at the High Power Microwave Test Facility at White Sands Missile Range in New Mexico. Tests were very successful.

3D printed all-dielectric conformal FSS survives 30 MW of microwave power.

Crossed grating all-dielectric FSS survives same test at 30 MW.

**Figure 1.** Illustration of diffraction of an applied beam by the grating.

**Figure 2.** Graphical representation of the leaky mode within the slab waveguide.

**Figure 3.** Regions of resonance for a guided-mode resonance device.

**Condition for Waveguiding:**

$$ n_0 < \frac{\lambda}{d} $$

**Regions of Resonance:**

$$ n_1 - n_0 \sin \theta_{int} = \frac{\lambda}{d} $$

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