National Radio Astronomy Observatory
Tech Transfer

Surface Treatment for Non-Specular Reflection

A Reflective Surface with Absorber-Like Behavior

The NRAO has developed a method of treating reflective surfaces to reduce undesired reflections causing standing waves leading to signal drop-outs and antenna side lobes. The surface is constructed of small cells such that the relative phase of reflections from individual cells is randomized so that the reflections do not sum constructively or destructively.

Reduction of undesired reflections is typically done by re-orienting or covering the reflecting surfaces with electro-magnetic absorber, but often the surfaces are integral to support structure where it can be expensive to adapt from a simpler design, or exposed to weather where it can be problematic to weather-proof a material not typically exposed to the elements while preserving its absorption capability. In situations where desired signals are weak, emissions from ambient temperature absorber can increase the noise figure of a receiving system rendering it less sensitive than optimum.

Major Benefits

By applying the treatment to antenna support structures the reflections that cause side lobes can be reduced. This results in a better antenna pattern and reduced interference from unwanted signals.

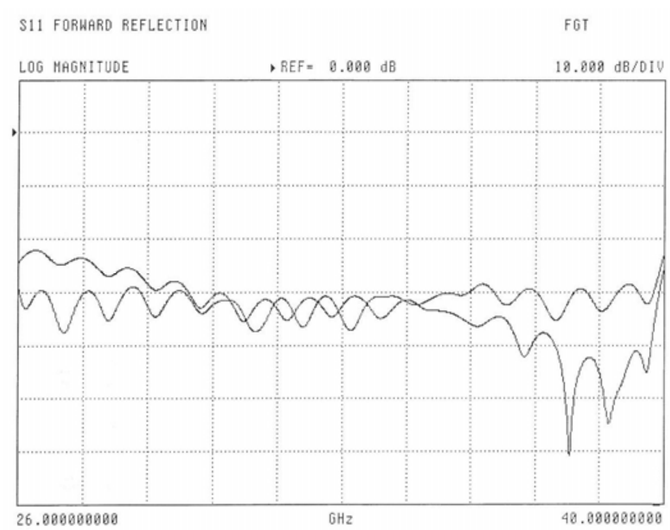
Applying the treatment to strategic resources reduces the radar cross-section and alters the radar signature of those resources.

Replacing electromagnetic absorber with this treatment can assist in reducing the system temperature of receivers for communications and radiometry.

Return Loss

Using standard gain test horns and a network analyzer the return losses of a flat plate, a plate covered with absorber and the random cell height plate of Fig. 1 were measured over 26-50 GHz. The cells of the random plate were square and 0.25 inches on a side, corresponding to 0.5 to 1 wavelength over the range of frequencies tested. The mouth of the horn was placed 15 cm from the plate so the path of emissions from the horn would be perpendicular to the plate. The horn was centered on the plate and the plate is large enough such that none of the main lobe of the horn spills over the edge of the plate.

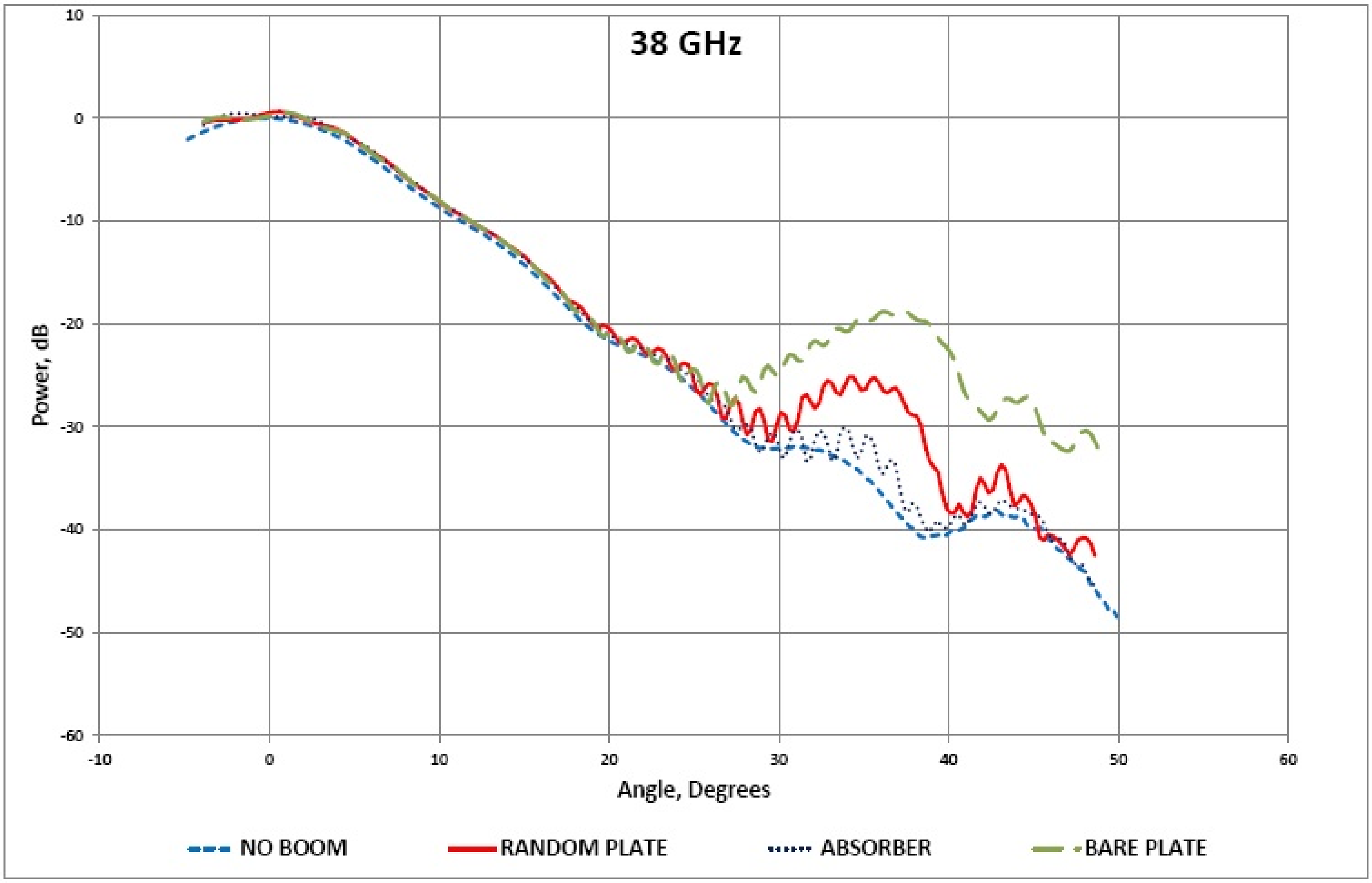
The plot of S11, Return Loss, shows a comparison between a plate with the non-specular treatment and an absorber-covered plate. The treated plate shows return losses of about -23 dB at 26 GHz and about -30 dB at 40 GHz, the absorber-covered plate showing -32 to better than -40 dB over the same frequency range.



Return losses of the random cell plate (top trace on both ends) and a plate covered with RF absorber.

Oblique Reflection Attenuation

Measurements were performed in an anechoic chamber with the plates placed in a configuration intended to approximate antenna support



Anechoic chamber test results at 38 GHz for the treated (random) plate, an absorber covered plate and a bare plate.

structures or other flat, reflective surfaces near a path of propagation that would cause interfering reflections. The test configuration was designed to cause an undesired reflection when the angle of incidence is 45 degrees.

Comparisons of the responses of a flat plate, an absorber-covered plate, a treated plate and the response of the test configuration with no reflective surface show performance of the treated surface similar to that of the absorber-covered surface.

Potential Implementations

For large areas of coverage sheet metal or foil can be formed against a master mold to create panels. To reduce weight, plastic sheets can be vacuum-formed against a master mold and painted with a metallic paint.

3-D printing is an ideal method to apply the technology to individual parts, covers, etc.