

Submission to 27<sup>th</sup> ESA Antenna Technology Workshop on Innovative Periodic Antennas: Electromagnetic Bandgap, Left-handed Materials, Fractal and Frequency Selective Surfaces

**Manufacture and characterisation of wide bandwidth, 3-D, EBG crystals for sub-millimetre antenna substrates.**

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3-D EBG crystals offer considerable advantages when used as substrates for planar antennas. Improvements include increased antenna directivity and the suppression of surface waves, reducing crosstalk between adjacent antennas. These advantages can be realised over a wide frequency range with suitably designed and fabricated EBG crystals. Details of the manufacture and characterisation of several EBG structures designed for a central frequency of 500 GHz are presented. These crystals are ultimately intended for use as the substrates of a prototype planar spaceborne imaging array.

The dielectrics used are high resistivity silicon,  $\epsilon_r = 12$ , and high permittivity ceramic,  $\epsilon_r = 36$ , with contrasting low  $\epsilon_r$  material provided by air or vacuum. The EBG crystals include silicon woodpiles, fabricated by deep reactive ion etching, ceramic woodpiles made using a precision dicing saw, and ceramic MIT structures, the manufacture of which requires the use of both the dicing saw and of laser ablation to drill cylindrical holes. Broadband transmission measurements indicate fractional normal incidence bandgaps of about one quarter of the centre frequency, in good agreement with the predictions of numerical modelling. Quantitative results on the manufacturing tolerances achieved by the different techniques are also presented: our numerical analysis shows that these need to be typically kept to within  $\pm 5 \mu\text{m}$  of design values to prevent degradation of the electromagnetic performance.