Microwave Transmissivity of Sub-Wavelength Metallic Structures

Submitted by **James David Edmunds**
to the University of Exeter
as a thesis for the degree of
Doctor of Philosophy in Physics
May 2011

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Signature: ……

Abstract

The use of patterned metallic surfaces for the control of the transmission of microwave radiation has been reinvigorated in recent years due to the success and interest in metamaterial research. These metallic periodic structures, commonly referred to as frequency selective screens (FSSs), allow responses to be tailored according to the geometry of the metallic structure as opposed to the material composition. A consequence of the presence of a metallic corrugation is the possible excitation of surfaces waves (commonly referred to as surface plasmon polaritons at visible frequencies). Surface waves can be utilised to achieve further control of the transmission properties of a structure. In this thesis several highly original metallic structures are investigated which use FSS and surface wave concepts. These structures exhibit interesting and previously unexplained transmission behaviour.

The experimental chapters within this thesis are divided into two areas. The first three experimental chapters (4-6) present original investigations into the excitation of diffractively coupled surface waves on metallic hole/patch arrays and their role in the enhanced transmission/reflection of microwave radiation. The importance of metallic connectivity within arrays is highlighted through measurements of the metallic filling fraction dependence on the transmission properties of regular periodic and random arrays.

The last two experimental chapters (7-8) contain investigations into the transmission properties of two novel resonant cavities. The structure studied in chapter 7 provides a mechanism for remarkably enhanced microwave transmission on resonance through an otherwise opaque continuous thin metal film. The second resonant cavity structure in chapter 8 uses a resonant array of metallic crosses to form a ‘resonant mirror’ Fabry-Perot cavity. These resonant FSSs exhibit a frequency dependent transmission/reflection and phase response thus producing an interesting series of modes which have very different properties to those supported by a non-resonant mirror etalon.

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