Meta-atoms for use in microwave circuits and antennas using additive manufacturing

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In the 'metamaterial' world there has been an enormous research effort into novel and unusual material properties that can find suitable uses in many microwave and antenna applications. In an attempt to produce a formalism that classifies these properties we have introduced the concept of meta-atoms (MTAs). These 'meso' scale particles have typical sizes much less than the wavelength at which they will be operating. They could therefore be assembled to form synthetic materials of some predefined properties required for a particular application. A grand challenge UK EPSRC project called SYMETA (Synthesizing 3D Metamaterials for RF, Microwave and THz Applications) has been established to study and classify these meta-atoms and produce structures that can be manufactured with Additive Manufacturing (AM) techniques, such as 3 D printing. In light of this background on MTAs, this presentation will focus on the topic of artificial synthesis of materials. We will review the different strategies that have been proposed, will identify the ones that have been successfully implemented, provide several practical examples of the same, and go on to discuss the challenges that still need to be met--not least of which is the cost-effective AM fabrication--to satisfy the ever-increasing demands posed by emerging technologies, such as IoT and 5G. In this context, we will briefly describe SYMETA at Loughborough University, whose first goal is to synthesize a palette of 3D meta-atoms using suitable materials and construct designer-specified 3D arrangements of meta-atoms using process efficient AM to create metamaterials. Low-cost fabrication of MTAs is also being pursued at SYMETA and will be covered in this talk. For example, two MTA based structures representing a capacitive impedance and a band pass filter have been designed and manufactured within the SYMETA consortium, as shown in Fig1.

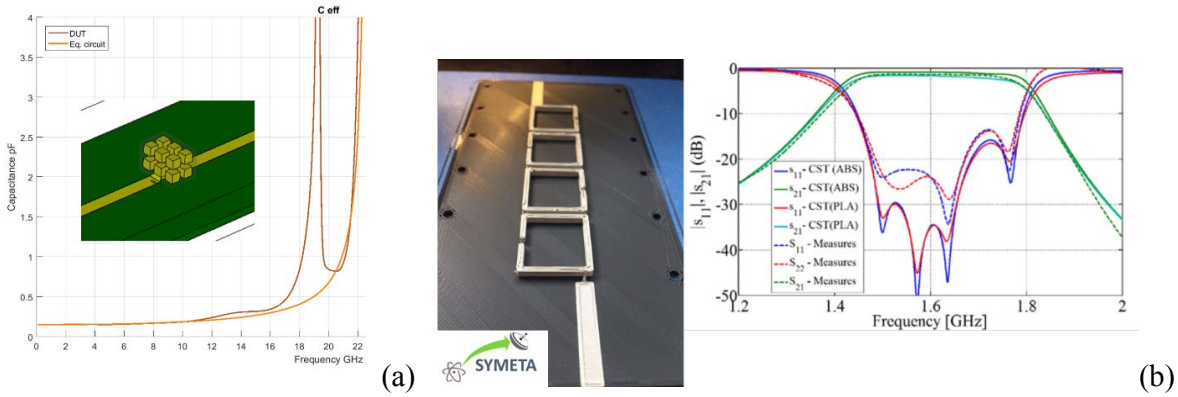

Figure 1. Exemplars of cuboid and split loop MTAs in (a) capacitive impedance and (b) band pass filter circuits