Numerical algorithm for generating the geometry of Spatially Variant Anisotropic Metamaterials (SVAMs) in 3D circuit

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Almost all electromagnetic structures and high frequency circuits have planar geometries. 3D printing will allow conventional planar designs to become 3D and fully exploit the benefits of the third dimension. Circuits will be smaller, weight less, made into unconventional form factors, be more power efficient, and exploit physics that is impossible in two dimensions. Even more degrees of freedom are offered by anisotropy and spatial-variance that will further improve performance of 3D circuits over 2D circuits. Evolving out of the traditional planar topology produces some serious challenges like electromagnetic interference, mutual coupling between components, power distribution, thermal management, and so on. The problems of interference and mutual coupling will be magnified exponentially due to the lack of a traditional ground plane and dense arrangement of components.

Metamaterials are engineered composites that are purposely engineered to provide material properties that are not attainable with ordinary materials. The EM Lab has developed spatially-variant anisotropic metamaterials (SVAMs) to mitigate mutual coupling and interference through their ability to reshape the near-fields between the components. SVAMs can be incorporated with near-zero added size, weight and cost because they simply replace the dielectric that would exist between the components anyway.

The long term vision is to fill the space in 3D high frequency circuits and electromagnetic systems with SVAMs in order to reduce interference and mutual coupling. This will solve many of the problems preventing us from fully utilizing the third dimension. However, the research is stuck until an algorithm can be developed to generate the geometry of the SVAM that fills the space around all of the components and conforms smoothly around them. The proposed research will develop this numerical algorithm and demonstrate it in a real device.