Origami-Inspired Frequency Selective Surface

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In electromagnetic design, device reconfigurability allows for advantageous new applications with the ability to change polarization, frequency, directionality, shape, size, or any combination of these parameters. For this work, the reconfiguration is achieved spatially using a geometrically defined origami fold. The Miura-ori fold was originally designed for the deployment of solar panels in space due to its ability to compress a large rigid surface area into a small volume for transport. This fold pattern has proven in recent years to be of interest in electromagnetics for antenna arrays that maintain directionality through intermediate fold angles as well as for frequency selective surfaces that act as spatially tuned stop-band filters with frequency agility through folding. Previous work on origami-inspired frequency selective surfaces gave promising results in the S-band (2 – 4 GHz) using dipole elements and has inspired further inquiry into the capabilities of this design at higher frequency bands.

In this work, the X-band (8 – 12 GHz) was explored. Spiral elements were chosen as filtering components due to their polarization independence, ease in scalability, and compact nature. The spiral filter elements were designed in Ansys HFSS and fabricated in Ag-TPU ink atop a polypropylene substrate in a tessellated formation. These spirals were tessellated in a hexagonal lattice after an initial case study on lattice designs. Much of this work focuses on the exploration of fabrication techniques to produce these printed samples with a level of accuracy and precision necessary to achieve favorable results. These frequency selective surfaces are designed with spiral electromagnetic structures resonating in the X-band, and therefore possess small feature sizes requiring complex print abilities.

The purpose of this project is to design, simulate, and characterize an origami-inspired frequency selective surface leveraging the fabrication capabilities of high resolution metal ink printing at the Air Force Research Laboratory.