High Radiation Efficiency Phase-change Material Antennas with Conductive Inclusions

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To deal with ever increasing congestion in the electromagnetic spectrum, it is desireable for communications and sensing systems to be spectrally agile–having the ability to operate in any number of widely separated bands, and often with dynamically adjustable radiation patterns (e.g., beam-steering). Wideband and tunable antennas can provide a means of accessing a wide range of frequency bands but have fixed and pre-defined radiation pattern, match, and polarization which are constrained to the original design intent.

Reconfigurable antennas have been recently investigated to allow for in-situ selection of operating frequency, radiation pattern, and polarization. They are often realized with liquid metals or foldable origami structures. Another possible realization is with the family of phase-change materials which, by various mechanisms such as heating, can undergo a conductivity change of several orders of magnitude. These phase-change materials offer a compelling solution to fully programmable and reconfigurable antennas. However, their relatively low conductivity in the metallic state (10^5 S/m) results in low radiation efficiency.

In this talk, we will present simulations and measurements of high radiation efficiency reconfigurable antennas based upon our recent work developing a low-loss composite phase-change material. The radiating structure is a monopole antenna comprised of a vanadium-dioxide (VO_2) film with conductive metallic inclusions that reduce ohmic loss. Several different VO_2 and metal antennas and measured and compared. We consider operating frequency, input match, radiation characteristics, and radiation efficiency.