

Public Abstract

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Department:Electrical Engineering

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Title:The Development of High Dielectric Constant Composites and Their Application in a Compact High Power Antenna

The volume and weight of high power antennas can be a limiting factor for directed energy systems. By integrating high dielectric constant materials into an antenna structure, it is possible to reduce the physical size of some antenna systems, but conventional high dielectric constant materials do not have adequate dielectric strength and mechanical properties. This work, undertaken to address the material requirements and demonstrate application in a high power antenna, encompasses the following four areas: 1. Development of high dielectric constant composite materials for integration in high power antennas; 2. Characterization of the composite materials through measurements of the permittivity and dielectric strength along with analyses based on thermogravimetry, scanning electron microscopy, and 3D modeling; 3. Design, simulation, and low power measurement of a high peak power antenna including the materials; 4. Design and construction of an antenna driver for high peak power antenna evaluation.

Through novel techniques, including trimodal particle packing, in-situ polymerization, and fluid void filling, three classes of high dielectric constant composites have been developed with dielectric constants of approximately 45, 100, and 550 at 200 MHz. A dielectric resonator antenna has been designed, simulated, and constructed for peak power operation up to 1 GW based on a resonator with a dielectric constant of 100. Antenna simulations and measurements have characterized the antenna performance, showing a primary band of operation between approximately 605 MHz and 1.1 GHz. A high power antenna driver capable of producing a high power damped sinusoidal RF burst was designed and constructed based on an inductive energy storage system that pulse charges the antenna under test and an oscillator to greater than 225 kV.