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Investigation of Sterolithographic Laser Additive Manufacturing Resins for Pulsed Power Applications

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Polycarbonate dielectrics like Lexan and polyetherimides such as Ultem have long been used as dielectrics in Marx generators, Blumlein lines, and in other pulsed power devices. These materials have relatively high voltage hold off and tensile strength, and are typically machined out of raw stock. The principal drawback of these materials is the cost of raw stock, machining time, and the need for higher voltage holdoff capability. Modern High Power Microwave (HPM) sources capable of gigawatt power with a compact footprint require an associated compact pulsed power driver that can hold off 100s of kilovolts for extended periods of time. The smaller volume of these devices, of course, places greater electrical stress on the dielectrics of the device. Photopolymers that polymerize with photons of UV wavelength are the basis for new stereolithographic additive manufacturing 3-D printers. These printers can produce not just prototype dielectric structures, but also fully operational dielectrics ready for use in a high energy pulsed power machine. Such printers have been used to manufacture pressurized spark gap switches for UNM's 10 stage, 10 kJ high energy, high voltage Marx generator. This presentation discusses empirical measurements of voltage hold off, both pulsed and DC, for various photopolymers as well as some initial dielectric permittivity measurements based on Sparameter analysis at low to medium frequencies.
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