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Study of the Nonlinear Phenomena in Ceramic Dielectric Composite Used in Compact PFLs+

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There is a growing interest in the development of dielectric materials of high voltage breakdown strength used in compact pulse forming lines (PFLs) to drive high power microwave (HPM) sources and pulsed lasers. Therefore, much attention has been paid to polymer-ceramic composites, where normally the ceramic powders with high dielectric constant are dispersed in a polymer matrix of high breakdown strength (BDS). Therefore, we have tested composite samples made of barium titanate (BaTIO3) as the ceramic powder and epoxy or polymethyl-metacrylate (PMMA) as the matrix polymer. Because of the polymer mixture, we have measured higher BDS compared to the pure ceramics of the order of 2.55 MV/cm for the epoxy-barium titanate composite (with ε= 40) and 420 kV/cm for the PMMA-barium titanate composite (with ε=25). However, as pointed by [1] the use of barium titanate in the PFL dielectric can distort the pulse waveform generated on the load as BaTiO3 is highly nonlinear, i.e. not leading to a rectangular output pulse as desired. To circumvent that this paper addresses this issue by proposing the manufacturing of the polymer-ceramic composite based on PZT (lead-zirconium-titanate) ceramics of weak nonlinearity for use in PFLs. This proposal will be discussed by showing the Weibull plots of the polymer composites and the nonlinear characterization tests of the PZT and BaTiO3 ceramics.

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[1] L.S.C Bendixsen and P.W. Smith, "Very low impedance forming lines built from ferroelectric tiles,"in Proc. of the 2005 IEEE Pulsed Power Conference, Monterey, Monterey, CA, Jun. 2005, pp. 1333-1336.

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