# Ultrasonic Characterization of Damage in Multilayer Ceramic Capacitors

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Multilayer ceramic capacitors (MLCCs) are vital circuitry components but are prone to cracking caused by electromechanical stresses generated during manufacturing, handling, or assembly. Increased leakage or short circuits can lead to unexpected component failure if cracks remains undetected. This work uses high frequency (100 MHz) focused ultrasonic scattering methods to nondestructively detect and characterize sub-surface cracks induced by high rate, high voltage application. 1812 X7R 100 Vr MLCCs (0.5 μF) were electrically and ultrasonically characterized in both a pristine state and after high voltage dielectric breakdown at 100 V/s. Absolute amplitude of reflected ultrasonic waves from the back surface of samples was used to determine the presence of cracks perpendicular to the ultrasonic wave propagation. Relative attenuation, a measure of ultrasonic wave scattering, was used to visualize cracks of various orientations. Cracks ranging from 75 μm to 6 μm in width were ultrasonically detected in each sample and verified with cross-sectioning. Two types of damaged samples were observed: surface and non-surface damaged samples. Surface damage samples had high attenuations in the damaged region and close to zero back surface reflection indicating the presence of large cracks and/or a high density of cracks. Ultrasonic measurements also revealed that most samples had cracks extending away from the visible damage region indicating widespread damage. However, one sample's ultrasonic amplitude map indicated the damage was isolated to the visible damage region. This suggests that the origin of the dielectric breakdown event in the sample with isolated damage was in the region of blow-out. Ultrasonic measurements of non-surface damage samples revealed extensive cracking across the entire part suggesting a higher density of cracks compared to samples with visible surface damage. Differences in crack behavior could indicate a different failure mechanism or origin of failure compared to samples with visible damage.