STUDY ON MICROWAVE SINTERING OF MULTILAYER CERAMIC CAPACITORS

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A microwave sintering technique has been developed for Ag-Pd and base-metal electrode (BME) multilayer ceramic capacitors (MLCCs). Commercial green chips of size 0805 MLCCs with Ag-Pd internal electrode and size 0603 MLCCs with nickel internal electrodes were sintered in a microwave field of 2.45 GHz. With a specially designed susceptor/insulation configuration to optimize coupling and uniformity of heating, a number of sintering experiments were conducted in the temperature range of 1000ºC –1100ºC in air for the Ag-Pd electrode MLCCs, and 1200ºC to 1250ºC under partially reducing atmosphere for BME MLCCs in a multimode microwave cavity. It was found that the Ag-Pd electrode MLCCs could be sintered by the microwave processing within a few minutes, and BME MLCCs less than a half hour. Microstructure of the microwave processed MLCCs was investigated with scanning electron microscopy (SEM). The dielectric properties of the microwave sintered MLCCs were measured and compared with those sintered using conventional process. The conventional sintering of BME MLCCs was carried out at 1320ºC and lower po_2's ($\approx 10^{-9}$ atms). The results demonstrate that nickel electrodes remain metallic after microwave sintering even though the po_2's were relatively high ($\approx 10^{-6}$ atms) and would thermodynamically favor formation of NiO. The microwave sintered samples showed a dense, fine and uniform microstructure. The properties of the microwave-sintered samples were comparable to the conventionally sintered samples. The microwave processing was found to have enhanced sintering kinetics of the MLCCs, lowering sintering temperature by 50-100ºC and also the processing time by up to 90%. The performance distributions in batch firings were relatively well controlled, and demonstrated standard deviations acceptable indicated further promise of this technology for mass production of capacitive devices.