Cold Sintering Process of $BaTiO_3$-PTFE Nanocomposites

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Abstract: Cold Sintering Process (CSP) have attracted much attention because of sintering various ceramics such as $BaTiO_3$, ZnO, LAGP, and $(K,Na)NbO_3$ at the low temperature. Under typical conventional sintering, the ceramics are densified at temperatures more than 1000 ˚C. On the other hand, it is possible to prepare the sintered body below 300 ˚C which have the relative density more than 90 % by CSP. CSP drive the densification by the following characteristics: uniaxial pressure, a transient flux and open system operating at a moderate temperature in a short time. By adding fluxes such as base and acid, they have an effect on the atomic dissolution, diffusion, and precipitation on the surface of the particles. The chemo mechanical process has been known as pressure solution creep. In the open system, components of the flux exhaust from the gaps between the die walls and pressing plungers. As a result, it is possible to densify the ceramics and ceramic composites at low temperatures.

$BaTiO_3$ has been used for electronic components known as multi-layer ceramic capacitors (MLCCs). MLCCs are electronic components used for electronic vehicles and smart mobile phones including 5G and beyond. Also, CSP has been enabled to densify $BaTiO_3$-composites with polymers such as PTFE and PPO at low temperature. $BaTiO_3$-composites could provide a high dielectric permittivity, low loss, broad temperature dependences, and reduced non linearities in terms of voltage saturation, electrical conduction. The composites have the potential to limit oxygen vacancy migration that has effect on reliability and breakdown.

In this study, we focused on $BaTiO_3$-PTFE composites with nano sized PTFE. We confirmed that the temperature dependences of the dielectric property were flattened, and the dielectric losses was improved. The leak current density of the composites suppressed and the reliability of the composites was improved, compared to the cold sintered $BaTiO_3$.