

Novel Mechanochemical Fabrication of Electroceramics

ABSTRACT

A novel mechanochemical fabrication technique for producing electroceramics using oxides as the starting materials is disclosed. It is perfectly suitable for fabrication of the entire electroceramic family including: (i) relaxor ferroelectrics (lead magnesium niobate, $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ or PMN, and PMN-based compositions, such as $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ - $\text{Pb}(\text{Zn}_{1/3}\text{Nb}_{2/3})\text{O}_3$ - PbTiO_3 or PMN-PZN-PT, $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ - PbTiO_3 or PMN-PT); and (ii) piezoelectrics (lead zirconate titanate, $\text{Pb}(\text{Zr}_{1-x}\text{Ti}_x)\text{O}_3$ or PZT and PZT-based compositions, such as lead lanthanum zirconium titanate or PLZT). The fabrication technique starts with mixing of the widely available and low-cost industrial ceramic powders of various oxides and the designed electroceramic phases are formed by reacting the oxide powders in a mechanochemical chamber, which consists of a wear-resistant cylindrical vial and one or more solid balls inside. The reactions are activated by mechanical energy or a combination of mechanical energy and thermal energy and can be completed at room temperature or temperatures above or below room temperature in a time period preferably ranging from a few minutes to tens of hours, depending on the types of electroceramic. Sintered electroceramic materials and components are fabricated when the compacts or green bodies made of the resulting ceramic powders are densified at the sintering temperature. The newly invented technique can be used to fabricate a wide range of electroceramics such as PMN, PMN-based relaxor ferroelectrics, PZT and PZT-based piezoelectrics at sintering temperatures as low as 900 °C.

Figure 3 is to be published.