Chemical synthesis of $KNbO_3$ and $KNbO_3$–$BaTiO_3$ Ceramics

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$KNbO_3$ is a technologically interesting material because of its high-temperature ferroelectricity and piezoelectricity, especially because it does not contain poisonous lead. Apart from its applications as a high-temperature ferroelectric or piezoelectric material, it was also tested as a material with a positive temperature coefficient of resistivity (PTCR). The applications of lead-free $BaTiO_3$-based ceramics with a PTCR are restricted to temperatures below ~ 130 °C. In order to increase the temperature range of lead-free PTC-resistor operation to higher temperatures, new PTCR materials are needed. Among the possible materials, lead-free ferroelectrics with high Curie temperatures (T_C) are of particular interest. KN is a ferroelectric material with a T_C of 415°C, thus giving it, and its solid solution with $BaTiO_3$, the potential to be materials for high-temperature PTCR applications.

In our earlier studies the PTC-resistors based on $KNbO_3$–$BaTiO_3$ solid solutions were prepared by conventional solid-state ceramic technology. The ceramics were produced in a semiconducting form by atmospheric reduction. Subsequent reoxidation of the grain boundaries in these semiconducting ceramics resulted in the appearance of a significant PTCR effect. However, the PTCR effect degraded at elevated temperatures, most probably due to the fine-grained structure and the non-homogeneity of these ceramics. It appeared that the microstructure of the ceramics needed to be controlled further in order to improve the PTCR effect in $KNbO_3$–$BaTiO_3$ ceramics.

The preparation of $KNbO_3$–$BaTiO_3$ ceramics using conventional solid-state technology is relatively difficult due to the large differences in the properties of the cations involved. To prepare ceramics with a microstructure appropriate for PTC resistors, the homogeneity of the starting powder needs to be increased.

In this study, we report on a Polymerised Complex Method (PC method), based on the Pechini-type reaction route for the preparation of homogeneous $KNbO_3$–$BaTiO_3$ ceramics, starting from an aqueous precursor solution of the respective metal-complexes.