Seed-free solid-state growth, structure and electrical properties of bulk KNN-based crystals

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Lead-free materials and devices have become the aim which people are pursuing since lead is harmful to human living environment. $K_{0.5}Na_{0.5}NbO_3$(KNN) system is one of the most promising lead-free piezoelectric materials to replace lead. In theory, the piezoelectric properties of single crystals are much better than those of polycrystalline materials. However, due to the existence of volatile elements such as K and Na etc., it is difficult to prepare KNN crystals with uniform chemical composition by high-temperature melting methods, which also requires complex and expensive equipment. Recently, we have successfully prepared a series of KNN-based crystals with centimeter-scale size by using a seed-free, solid-state crystal growth method, and then through subsequent atmosphere annealing processes, the piezoelectric coefficient of the KNN crystal reaches more than 1000 pC/N, which is far higher than that of pure KNN ceramics. At the same time, the crystal also has high Curie temperature and good ferroelectric and dielectric properties. In addition, both the method and prepared KNN-based materials are environmentally friendly. It is expected to use this simple method to prepare large-size KNN-based lead-free piezoelectric single crystals that meet industrial requirements.

References

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