Tailoring the Properties of Bulk $BaTiO_3$ Based Perovskites by Heteroatom-Doping towards Multifunctional Applications: A Review

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Abstract

Dielectric barium titanate-based perovskite ($BaTiO_3$) has emerged as one of the most popular multilayer ceramic materials for its versatile properties. However, the intrinsic properties, particularly the dielectric, ferroelectric, piezoelectric, and electrical properties of natural barium titanate perovskite (BTP) are not as attractive as required for its multifunctional applications. In recent years, the doping technique has been widely studied for improving the desirable properties of BTP ceramic to expand its practical applications in various advanced technologies. Considering the latest research and developments, this review aims to discuss the synthesis techniques of hetero-atom doped BTP, together with doping status, such as doping sites, doped content, and surface-to-volume ratio. We also critically analyze the effects of co-factors (e.g., sintering temperature, grain size, Curie temperature, and compositions of hetero-atoms) on the structural, and electronic properties of BTP. In addition, optimization of the doping requirements for obtaining the desired improvements of the target properties is also discussed, coupled with providing a comprehensive discussion on the synthesis pathways. Subsequently, diverse applications of the heteroatom-doped BTP are exemplified. Finally, major challenges and future outlooks are highlighted from the perspective of different applications of BTP.