Technology Offer

High Ferroelectricity: First Method for Production of Bulk SnTiO3

Ref.-No.: 1201-5559-BC

The invention relates to a new method of producing $SnTiO_3$ for the use as a ferroelectric element. Tin titanates are known to be a class with various properties making it promising for many applications. The preparation of this material beyond thin films remained challenging.

Tin(II) oxide has a low disproportionation temperature of 350°C but the preparation of new materials is usually conducted at higher temperatures. Therefore, bulk $SnTiO_3$ is not possible to be produced using existing methods.

Following the newly developed method a way is provided to prepare bulk $SnTiO_3$ and the respective process is perfectly scalable to industrial applications as well. Due to its significant ferroelectric properties an implementation in various applications like FeRAM or actuators allows for the construction of highly advanced electric devices.

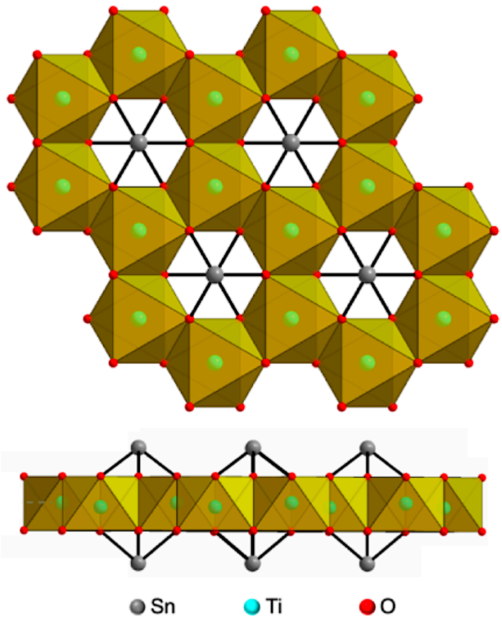

Fig. 1: Illustration of the crystal structure of SnTiO3. The newly developed method according to the invention allows for the large-scale preparation of this bulk material. It is favorable for various applications, especially due to its ferroelectric properties.

Advantages

- First method for the preparation of bulk SnTiO3
- Applicable in industry relevant scale
- Access to diverse class of materials
- Validated by scanning transmission electron microscopy

Applications

- Ferroelectric random-access memory (FeRAM)
- Tunable capacitors
- Ferroelectric funnel junction element (FTJ)
- Multiferroic element
- Piezoelectric for ultrasound imaging
- Electro-optical elements for data storage
- High precision actuator

Max-Planck-Innovation GmbH
Amalienstr. 33
80799 München
www.max-planck-innovation.de

Background

$SnTiO_3$ it is a highly promising ferroelectric material but an accordingly large effort to prepare this material in larger amounts remained unsuccessful. Some approaches using temperatures of up to 800°C caused unwanted disproportion and oxidation processes of the initial SN(II). The production of thin film $SnTiO_3$ via atomic layer deposition and pulsed laser deposition was suggested by different groups. However, these expensive methods are not applicable to large industrial scale and the limitation to thin films makes them insufficient for various relevant applications of the material.

Technology

To overcome the aforementioned shortcomings, an advanced method for the preparation of bulk $SnTiO_3$ was developed. The method comprises three independent steps.
At first, a mixture of an alkali metal salt and a titanium(IV) oxide are reacted to form layered alkali metal titanate. Ideally, this reaction is conducted at a temperature of 550°C to 650°C over a duration of 12 hours but also other parameters are possible. In the second step of the method, the alkali metal titanate is ion exchanged with tin(II) salt. In this process tin(II) ions are fully or partially substituted for the alkali metal ions and tin-exchanged alkali metal titanate is obtained. In the final step, this material is dehydrated and subsequently annealed in an oxygen free atmosphere at a temperature below the disproportion temperature of tin(II), thus obtaining $SnTiO_3$.
The process according to the invention gives access to new bulk $SnTiO_3$ materials, which can be obtained in a high purity. Surprisingly, the method according to the invention allows the preparation of new crystalline structures of $SnTiO_3$ and $SnTi_{1-x}M_xO_3$ for various x and M. The method is scalable and allows the production of ferroelectric $SnTiO_3$ for industrial applications.

Patent Information

PCT *(WO2019211372A1)*, EP, US, JP, CN

Publications

Diehl et al. *“Structure-Directing Lone Pairs: Synthesis and Structural Characterization of $SnTiO_3$”*, Chem. Mater. 30 (2018)

Contact

Dr. Bernd Ctortecka
Senior Patent- & License Manager
Physicist
Phone: +49 (0)89 / 29 09 19 - 20
eMail: ctortecka@max-planck-innovation.de

Max-Planck-Innovation GmbH
Amalienstr. 33
80799 München
www.max-planck-innovation.de