Hydrothermal Synthesis of Submicron- to Nano-Sized Ferroelectric Powders: Properties and Characterization

Sukon Phanichphant[1] and Robert Bertram Heimann[2*]

[1]*Department of Chemistry, Chiang Mai University, Chiang Mai 50200, Thailand*

[2]*Department of Mineralogy, Technische Universitaet Bergakademie Freiberg, Freiberg, Germany*

**Corresponding author. E-mail: heimann@mineral.tu-freiberg.de*

ABSTRACT

Ferroelectric ceramics play an ever-increasing role as materials for electrical and electronic applications including multilayer capacitors (MLCs), dielectric resonators for frequency stabilization of microwave circuits, low-noise oscillators and low-insertion-loss bandpass filters for microwave communication components, dielectric waveguide resonators, piezoelectric transducers and sensors, piezomechanical actuators and motors, PTC thermistor, and a large variety of novel-emerging utilizations. The dielectric and electromechanic coupling properties of such ferroelectric ceramics are generally dependent on (i) dielectric permittivity, (ii) mechanical Q-factor and (iii) temperature coefficients of both resonance frequency and dielectric permittivity. These parameters in turn depend crucially on phase purity, impurity content, grain size and grain size distribution of the ceramic starting powder used to fabricate monolithic devices. Powder synthesis is customarily achieved by classical ceramic processing routes such as solid state reactions of constituent oxides, carbonates or nitrates. However, increasingly such methods are being employed that avoid repeated mixing, grinding and calcination steps through synthesizing the desired compositions from true or quasi-homogenous solutions by coprecipitation of hydroxides, sol-gel phase transition, or hydrothermal methods. Submicron- and nano-sized ferroelectric powders with favourable properties, synthesized by the latter method at the Department of Chemistry, Chiang Mai University and the Department of Mineralogy, Technische Universitaet Bergakademie Freiberg will be described in this contribution.

INTRODUCTION

Ferroelectrics are utilized as important components of a large variety of modern electric and electronic devices. As in all functional advanced ceramics, the performance of the endproduct will be determined to a large extent by the synthesis methods and hence properties of the ceramic precursor powders. In this contribution, the basic properties and physical underpinnings of ferroelectric materials will be discussed, as well as details on the hydrothermal synthesis of submicron- to nano-sized ferroelectric powders and their properties. Special emphasis will be devoted to research work performed jointly at the Department of Chemistry, Chiang Mai University, Thailand and the Department of Mineralogy, Technische Universitaet Bergakademie Freiberg, Germany.