شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها

علي هذه الأفلام قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأفلام بعيدا عن الغبار

في درجة حرارة من ١٥-٢٥ مئوية ورطوبة نسبية من ٢٠-٤٠%

To be Kept away from Dust in Dry Cool place of 15-25- c and relative humidity 20-40%

بعض الوثائق

الاصلية تالفة

بالرسالة صفحات لم

ترد بالاصل

Suez Canal University
Faculty of Petroleum and Mining Engineering
Metallurgical and Materials Engineering Department

THE PRODUCTION OF PIEZOELECTRIC MATERIALS

A Thesis
Submitted to
Metallurgical and Materials Engineering Department
Suez Canal University

For
The Master Degree of Science
In
Metallurgical and Materials Engineering

By

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English Abstract

In the present work, various synthesis routes are applied for the fabrication of bulk PZT ceramics. Firstly, the Solid-State Reaction route is adapted with either one or two stages. Secondly, Sol-Gel route using two selected solvents, Ethylene Glycol Monomethyle Ether, and, Acetic acid are used. The results indicated that, the preparation of stoichiometric composition without excess PbO of PZT ceramics by One-Stage Solid-State Reaction requires a high processing temperatures to form the PZT ceramics. In the Two-Stage Solid-State Reaction route a lower processing temperatures is proven to be required to form PZT materials. This temperature is lower than that one used in the previous method by 100-200°C. In the route of using acetic acid as a solvent is observed to produce the best structure and consequently the best electrical properties of PZT ceramics produced by the previous routes.

Key words	**Ceramic, Piezoelectric Materials, PZT, Dielectric constant, Microstructure, Sintering and calcination processes.**

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Adel M. Amer

ABSTRACT

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Most of the rencently development of piezoelectric ceramics has focused on piezoelectric ceramic materials research and, in particular, on developing new materials. These materials should have the dielectric and piezoelectric properties required for use in the desired piezoelectric ceramic devices. The vast majority of piezoelectric ceramic materials found in the marketplace today are lead zirconium titanate (PZT). They have a perovskite structure, and are characterized by high dielectric constant, low dielectric losses, and high electromechanical coupling factors.

In the present work, various synthesis routes are applied for the fabrication of bulk PZT ceramics. Firstly, the Solid-State Reaction route is adapted with either one or two stages. Secondly, Sol-Gel route using two selected solvents, Ethylene Glycol Monomethyle Ether, and, Acetic acid are used. PZT ceramics with a composition, ($Pb(Zr_x Ti_{1-x})O_3$, x= 0.52-0.53), near the morphotrobic phase boundray (MPB) in the presence of excess lead oxide are produced using the various suggested routes. However, the basic composition is kept constant, for One-Stage Solid-State Reaction route, excess lead is added in different amounts of 3 or 5 mol% PbO in order to determine the effect of lead deficient. Also, in the Two-Stage Solid-State Reaction route, the basic composition with another one of 3 mol% PbO are produced. Sol-Gel route using two different solvents (Ethylene Glycol Monomethyle Ether, and, Acetic acid) is applied to produce one PZT composition ($Pb(Zr_x Ti_{1-x})O_3$, x = 0.52) in the presence of 4 mol% excess PbO.

Characteristics of the produced PZT ceramic materials were determined using X-ray, metallographic examination (SEM), density measurements, and electrical properties measurements.

The results indicated that, the preparation of stoichiometric composition without excess PbO of PZT ceramics by One-Stage Solid-State Reaction requires a high processing temperatures to form the PZT ceramics. This leads to high losses of PbO, low reactivity of the powder, presence of second phase and compositional fluctuations with the subsequent effect of electrical properties deteriorations. In the presence of lead oxide both structure and electrical properties are observed to improve to large extent. The mechanisms of such effect have been examined in the light of the obtained results.

In the Two-Stage Solid-State Reaction route a lower processing temperatures is proven to be required to form PZT materials. This temperature is lower than that one used in the previous methhod by 100-200°C. As a result, a dense, relatively homogeneous and single phase structure is obtained without the need to excess PbO additions. The electrical properties is much better compared with those obtained in One-Stage Solid-State Reaction route.

The preparation of PZT ceramics by Sol-Gel route using ethylene glycol monomethyle ether as a solvent gives closed structure and electrical properties to the PZT ceramics produced by Two-Stage Solid-State Reaction route. In the route of using acetic acid as a solvent is observed to produce the best structure and consequently the best electrical properties of PZT ceramics produced by the previous routes.

In all the methods of production of PZT ceramics, reaction mechanisms and structures changes during various stages of production are carefully followed and related to the final material characterization and also compared with existing results relavant to method used.

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