Investigation of the Polarization Depth Distribution of PZT Thick Films by LIMM

Bernd Ploss[1]
W. Hässler[2], H. Hülz[2*)], G. Köbernik[2]
[1] The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China
[2]Institute for Solid State and Materials Research Dresden P.O.Box 270016, D-01171 Dresden, Germany

Abstract - The pyroelectric Laser Intensity Modulation Method (LIMM) was applied for the characterization of the polarization depth distribution of ferroelectric thick films. The influence of an corona discharge on the polarization distribution of polarized and depolarized regions was investigated. Inhomogeneities in the surface potential of corona charged films can be correlated to inhomogeneities in the microstructure by a x-y-scan of the sample at different modulation frequencies (pyroelectric tomography).

INTRODUCTION

The ferroelectric thick films investigated in this paper were developed for an electrostatic printing process [1]. In this process imaging is done by poling the film locally and subsequently developing the latent image of the screening charges by a liquid toner. The poling and the contrast enhancement is carried out by a corona discharge. This means the most important property of the film for this application is the switchable polarization. In this paper the depth distribution of the polarization during the corona polarization process and the influence of inhomogeneities inside of the film is investigated using the LIMM-method.

EXPERIMENTAL PROCEDURE

The investigated ferroelectric thick films (d≈100µm) consist of a low sintering $Pb[Zr_{1-x}Ti_x]O_3$-$PbMg_{1/3}Nb_{2/3}O_3$-material (PZT-PMN), deposited on a Au-metallized Al_2O_3-substrate (50x50 mm^2) and sintered at T=950°C [2, 3]. The thick films are characterized by a dielectric constant ε of 1500 at 1 kHz, a remanent polarization P_R of 15 μCcm^{-2} and a coercive field E_C of 0,8...1 $kVmm^{-1}$ (50 Hz sinus).
The polarization of the films with corona was done by applying a voltage of 6,5 kV between a 50 µm thick W-wire arranged 20 mm above the film surface and the ground electrode of the sample. During the charging process the polarization current was measured.

The electric surface potential was measured with an electrostatic voltmeter (ESVM) [4-6]. The sample was scanned with a motor driven x-y-table with the sensor of the ESVM being fixed above the sample surface in a distance of about 100 µm.

For the LIMM-measurements Al-electrodes (thickness 50 nm, ∅ 2mm) were evaporated on the film surface. The electrode was exposed to a laser beam (laser diode with $\lambda = 830$ nm) which was intensity modulated sinusoidally in the frequency range from 10 to $2x10^6$ Hz. The absorbed thermal energy generates a thermal wave which penetrates into the film. The attenuation and therefore the penetration depth of this thermal wave decreases with increasing frequency. Due to the pyroelectric effect the local temperature change in the film causes a pyroelectric current between ground and top electrode which was measured phase sensitive by a lock in amplifier. A measurement setup is shown in Fig. 1.

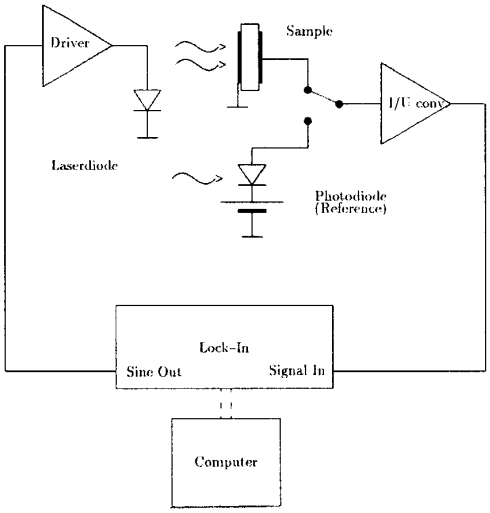

Fig. 1: Setup of the LIMM-measurement

The usual LIMM procedure is a one-dimensional technique [7]. The electrode is illuminated

0-7803-4959-8/98/$10.00 © 1998 IEEE.