Chapter 5
Fabrication and Characterization of Thin Film Capacitor With Ferroelectric Material

Abhishek Kumar
https://orcid.org/0000-0003-3961-9970
Lovely Professional University, India

ABSTRACT

Ferroelectric thin-film capacitors are a significant field of study in modern electronics due to they have several benefits, including high capacitance density, low leakage currents, and non-volatile memory characteristics. This chapter examines the fabrication and characterization strategies used in the creation of ferroelectric thin-film capacitors with dielectric BaTiO3 and PbTiO3 thin film deposited in the LaNiO3 electrode. The crystallographic analysis of deposited film is carried out using XRD and found that the film is crystalline with orientation (101) for BaTiO3 and (110) for PbTiO3. With SEM analysis, we found that the obtained grain size is 35 nm and 46 nm with the content of LaNiO3 5% and 10% respectively. The obtained capacitance value with a dielectric of BaTiO3 is 59.6 pF and PbTiO3 is 1.22 pF. The actuator based on a fabricated capacitor found a displacement of 0.368 mm with ±1V.

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1. INTRODUCTION

Capacitive sensors are essential parts of modern technology, with uses in consumer electronics, automotive, biomedical devices, and industrial automation, among other areas. These sensors are useful and necessary in both simple and complicated systems because they use variations in capacitance to detect a variety of physical properties. The ability of a system to hold electrical charge is the basis for the operation of capacitive sensors. Given two conducting surfaces, the capacitance C between them is given by equation (1)

$$C = \varepsilon A/d \tag{1}$$

Where is the permittivity of the dielectric material between the conductors, A is the area of the conductors facing each other, and d is the distance between the conductors. Variations in the area A, the distance d between the conductors, or the permittivity ρ of the dielectric material all affect the capacitance C.

The principles, design concerns, fabrication methods, and applications of capacitive sensors based on ferroelectric material are investigated in this chapter. Due to their special qualities and wide range of uses, ferroelectric materials have become essential parts of thin film capacitors, revolutionizing the capabilities of electronic devices. Ferroelectrics, in contrast to traditional dielectrics, show spontaneous polarization that is reversible in response to an applied electric field. Because of this inherent property, ferroelectric thin-film capacitors are excellent choices for high-density and non-volatile memory applications because they can store charge effectively and maintain their polarization state without a constant power source. Ferroelectric materials are included in thin film capacitors to take advantage of their good fatigue resistance, low coercive field, and high dielectric constant. These characteristics allow for new functions like energy harvesting, non-destructive readout memory, and piezoelectric sensing in addition to improving the performance of capacitive devices. In this chapter, the capacitor is fabricated with ferroelectric material as a dielectric film and $LaNiO_3$ has been used to develop the electrode terminal. The paper is organized as; section 2 puts light on the ferroelectric material of the dielectric. Thin-film development is elaborated in section 3 their characterization result is presented in section 4. Section 5 includes future scope and is finally concluded in section 6.