EFFECT OF THE ADDITION OF V_2O_5-TeO_2 GLASS ON THE MICROSTRUCTURE AND DIELECTRIC PROPERTIES OF $CaCu_3Ti_4O_{12}$

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ABSTRACT

EFFECT OF THE ADDITION OF V_2O_5-TeO_2 GLASS ON THE MICROSTRUCTURE AND DIELECTRIC PROPERTIES OF $CaCu_3Ti_4O_{12}$ CERAMIC

$CaCu_3Ti_4O_{12}$ (CCTO) is a well-known nonferroelectric material possessing high and nearly constant (room temperature to 300°C) dielectric constant at 1 kHz. It is being widely used in the electronic industries to manufacture electronic components such as multilayer capacitor (MLCC), DRAMs, microwave devices, electronic devices in automobiles and aircrafts. The properties like high dielectric permittivity of $CaCu_3Ti_4O_{12}$ depend upon the particle size and powder morphology. The particle size and powder morphology of $CaCu_3Ti_4O_{12}$ depend on the different processing parameters that are temperature, heating rate, duration and atmosphere. Recently, several studies have been performed on synthesis of $CaCu_3Ti_4O_{12}$ in addition with glass to attain a material with relatively high dielectric constant and low dielectric loss. $CaCu_3Ti_4O_{12}$ synthesized using solid state method is one of technique which possesses high purity and close control of powder morphology, which will result in the desired microstructure and dielectric behavior. Under this context the present study was carried out to evaluate the effect of different fraction of additive parameters on the phase purity, particle size and powder morphology of $CaCu_3Ti_4O_{12}$ to study the effect on microstructure and the dielectric behavior of $CaCu_3Ti_4O_{12}$. For preparation of pure $CaCu_3Ti_4O_{12}$ ceramic, the optimized ratio for synthesis of $CaCu_3Ti_4O_{12}$ was found to be 1:3:4 for $CaCO_3$, CuO and TiO_2. For preparation of V_2O_5-TeO_2 glass, the optimized the fraction of composition for V_2O_5 is 0.30 while 0.70 for TeO_2. The powder morphology, particle size, densification behavior and dielectric behavior of the sintered samples have been studied. The growth grain size is found to enhance the dielectric properties of composition by increasing the dielectric constant and lowering the dielectric loss. The dielectric study showed its dependence upon grain size and density. Dielectric constant increases with increase in mole fraction of glass addition composition.

CHAPTER 1

INTRODUCTION

1.1 Background

A dielectric is an electrical insulator that can be polarized by applied electric field. By placing a dielectric material between charged plates, an induced electric field opposing the direction of charged plate's field is produced. This induced field can store energy [4]. This property is useful in capacitor and other microelectronic memory devices. Most of dielectric ceramics are employed as ceramic capacitors and microwave resonators where high dielectric constant are required [1]. Due to high dielectric constant, the smaller capacitive component can be fabricated, thus offering the opportunity to decrease the size of electronic devices [14].

Electroceramics associated with high dielectric constants accompanied by low dielectric loss have been increasing demand owing to their potential applications in miniaturized electronic devices. Many other materials also have a large dielectric constant, such as $Bi_{2/3}Cu_3Ti_4O_{12}$ (BCTO), $Y_{2/3}Cu_3Ti_4O_{12}$ (YCTO) and $La_{2/3}Cu_3Ti_4O_{12}$ (LCTO). All these large dielectric constant materials have similar dielectric behavior, in which their dielectric constants are nearly independent of frequency and temperature well below the relaxation frequency. Among these, $CaCu_3Ti_4O_{12}$ has high dielectric constant due to internal barrier layer capacitance effect.