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Fourier transform infrared analysis of orange peel ferroelectric material with $BaTiO_3$ precursor

Rahmi Dewi, Yanuar Hamzah, Romarito Gesi Manurung, Ropina Emwarjati Sihombing, Lailatul Rahmi*, Rahmatan Lil Alamin, Figo Swarna Yoga, Sonia Salsabila, Ananda Febri Yudani
Department of Physics, Universitas Riau, Pekanbaru 28293, Indonesia

ABSTRACT

This study explores the potential of orange peel extract as a stabilizing agent in the synthesis of ferroelectric $BaTiO_3$. Characterization using Fourier transform infrared (FTIR) spectroscopy revealed the presence of strong acidic functional groups (O-H stretching at 3300 cm^{-1} and C–H sp^3 chain at 2800 – 2993 cm^{-1} and carbonyl groups of double C–O at 1650 cm^{-1} in orange peel extract. These findings indicate that orange peel contains organic compounds that can be utilized in various applications.

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* **Corresponding Author**
E-mail address: lailatul.rahmi2632@student.unri.ac.id

1. INTRODUCTION

Research on ferroelectric materials has been widely conducted. Ferroelectrics are dielectric materials that have strong spontaneous polarization. The advantages of ferroelectric materials are the ability to change internal polarization using an appropriate electric field and spontaneous polarization [1-3]. Ferroelectric materials have several unique properties, including high hysteresis and dielectric constant properties, pizoelectric properties, pyroelectric properties, linear optical properties for thin films [4, 5].

Barium titanate ($BaTiO_3$) with a tetragonal perovskite crystal structure has been known to be a ferroelectric material. This material has been widely used in applications in the electronics field because barium titanate is more environmentally friendly, has a lower Curie temperature than other dielectric materials, and has a high dielectric constant [6, 7]. $BaTiO_3$ is easy to apply because barium titanate has more stable chemical and mechanical properties. $BaTiO_3$ is one type of ABO_3 (A = mono or divalent and B = tri-hexavalent ion) ceramic material needed for ferroelectric applications [8-10].

Orange peel ferroelectric materials with $BaTiO_3$ precursor have attracted attention in various fields of technology and applications [11, 12]. Orange peel ferroelectrics have ferroelectric properties that can be used in various applications, such as electronic technology and raw materials. $BaTiO_3$ is a precursor used in the synthesis of ferroelectric materials, and has been known to have properties suitable for use as a precursor in the synthesis of ferroelectric materials [4, 13-15].

Fourier transform infrared (FTIR) analysis is a material analysis method used to identify and determine the chemical properties of materials [16, 17]. FTIR produces data in the form of intensity and frequency graphs, which show the level of the number of compounds and the types of compounds contained in a sample. FTIR has been used in various applications, such as analysis of the physical and chemical properties of materials, molecular identification, and material quality control [18-20].

The basic principle of FTIR is interferometry, where infrared radiation from a source is split into two beams and then recombined after traveling different distances. This difference in distance produces an interferogram, which is then converted into an infrared spectrum using the Fourier transform [21, 22]. Compared with dispersive infrared spectroscopy, FTIR has several advantages such as energy collection efficiency, higher resolution, and faster data acquisition. This makes FTIR a widely used technique in various fields, including chemistry, biochemistry, materials, environment, and others [18, 23-25].

2. RESEARCH METHODS

2.1. Materials and Tools

In this study, the main materials used were $BaTiO_3$, 70% alcohol, orange peel, and deionized water (DI water). BaTiO3 was used as an active material in the experiment. 70% alcohol was used for sterilization and cleaning of equipment, while orange peel was prepared as an additional material. Deionized water was used as a solvent and to rinse equipment after use. The tools used included storage bottles, magnetic stirrers for mixing solutions evenly, tongs for precise manipulation of materials, and beakers as mixing containers and measuring material volumes.

2.2. Methods

The experimental method began with the preparation of orange peels, which were washed thoroughly with deionized water and then soaked in 70% alcohol for sterilization. Furthermore, $BaTiO_3$ was measured and dissolved in deionized water in a beaker until it reached the desired concentration. The $BaTiO_3$ solution was then stirred using a magnetic stirrer for one hour to ensure even dispersion. After that, the prepared sterile orange peel was added to the $BaTiO_3$ solution and stirred again for two hours to allow for optimal interaction between $BaTiO_3$ and the additional components. The final mixture was transferred into a storage bottle for use in further testing. This process ensures that the materials and equipment are used in a manner that is appropriate and effective for the stated research purposes.

3. RESULTS AND DISCUSSIONS

In this study, $BaTiO_3$ doped with orange peel extract was identified its functional groups using FTIR spectroscopy characterization to determine the chemical components of $BaTiO_3$ doped with orange peel extract. The resulting infrared spectra are shown in Figure 1.

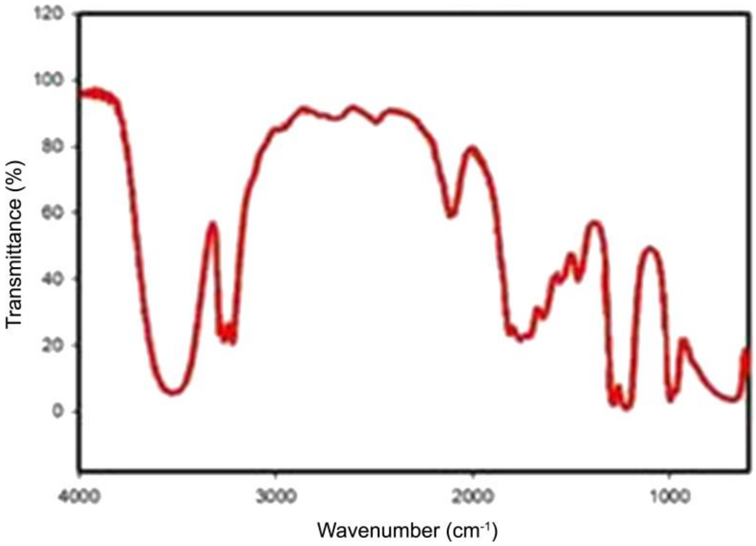

Figure 1. FTIR results of orange peel extract with $BaTiO_3$.

The results of the FTIR spectrum test were observed at wave numbers 3300 cm^{-1}, 2800 – 2993 cm^{-1}, and 1650 cm^{-1}. At wave numbers 3300 cm^{-1}, 2800 – 2993 cm^{-1}, it shows a sharp peak of O-H stretching and C-H sp^3 chains indicating that the sample contains strong acids according to the content of orange peel which tends to be acidic. The wave number 1650 cm^{-1} was observed, containing a double C-O bond that identifies the carbonyl group.

Table 1. Results of FTIR spectrum analysis of orange peel extract doping.

Functional group	Absorption peak position (cm^{-1})	Description
O-H and C-H sp^3	3300 cm^{-1}, 2800 – 2993 cm^{-1}	Wide and strong acid
C=O	1650 cm^{-1}	Carbonyl group

4. CONCLUSION

The results of the FTIR test showed that orange peels contain several functional groups that identify the presence of organic compounds. Sharp peaks at wave numbers 3300 cm^{-1} and 2800 – 2993 cm^{-1} indicate the presence of O-H stretching groups and C-H sp^3 chains, which are characteristic of strong acids. This is in accordance with the content of orange peels which tend to be acidic. In addition, the presence of a double C-O bond at wave number 1650 cm^{-1} indicates the presence of a carbonyl group. This carbonyl group is commonly found in organic compounds such as ketones, aldehydes, and esters. These compounds can be used for various applications, such as in the pharmaceutical, cosmetic, and food industries.

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