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Effect of factors on dielectric properties of pineapple leaf for microwave application

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ABSTRACT

Nowadays, dielectric materials are widely used in electronic applications, and their permittivity and loss tangent are important properties to consider. Dielectric materials made from waste can help reduce pollution and conserve resources. The aim of this work is to analyze the important factors in pineapple plantation waste preparation as dielectric materials using rapid two-level factor analysis in order to identify significant factors during preparation. It takes a short procedure to determine the optimum variable factor and leads to fast analysis. The dielectric material preparation process involves chemical treatment, sample fabrication, and sample characterization. Measurement of permittivity is performed by using a G-band rectangular waveguide. The highest dielectric permittivity is 3.31 where one of the suitable applications is used as an antenna substrate. The best factor in producing high dielectric permittivity is a 1:10 ratio of pineapple leaves to distilled water, 50 min of boiling time, using a heating effect, and 5 g weight of pineapple leaves powder. The most significant factor in producing high dielectric permittivity is the heating effect, which is contributed by the presence of carbon in the composite material.

1. Introduction

In industrial production, waste is recycled or reused to overcome the negative effects of potentially harmful chemicals that can have bad effects on the environment. Waste from food and kitchen waste can be decomposed and composted. It can be recycled and produced from a variety of resources with its proper management. Waste management includes a variety of processes such as waste collection, removal of impurities, recovery, and disposal, as well as waste disposal site management [1]. The waste management duties of the municipality include supporting waste separation to promote the growth of resource recycling from recoverable waste, reducing the amount of internal waste that ends up in landfills, and other related efforts.

Pineapples are fruits that can produce 75 % waste upon harvesting, with the majority being leaves [2]. Pineapple fruit is harvested after it has reached physiological maturity [3]. Pineapple waste has its own characteristics that can be transformed into a variety of useful products and resources. Some of the waste, especially pineapple leaf can be

utilized as raw material to produce dielectric material. Dielectric material properties refer to substances with extremely low electrical conductivity, resulting in the absence of current flow when voltage is applied. The main properties of dielectric material are electric susceptibility, dielectric polarization, dielectric dispersion, and dielectric relaxation [4]. It is an important property in communication [5] and microwave [6] applications. It controls how well the energy from high frequency alternating electric fields can be absorbed and how quickly the materials can be heated. Previous researchers utilized fruit waste to produce dielectric material such as from wollastonite [7], coconut oil [8], banana skin [9], neem oil [10], and pineapple fiber [11]. A low dielectric constant can be achieved by controlling various factors, including chemical [12] and non-chemical treatments [11].

Collecting, treatment, drying, grinding, mixing, sampling, and analysis are important techniques in dielectric material preparation. All the techniques can be described as a factor of parameters that give lower or higher effects to permittivity. For chemical treatment techniques, alkaline solutions are used to improve the moisture and adhesion

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