Effect of carbon composition on permittivity performance of dielectric material from agricultural waste

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ABSTRACT

Agriculture in several nations, including Malaysia, yields abundant waste like timber, oil palm waste, rice husks, coconut fibers, municipal waste, sugarcane residues, and pineapple byproducts. Fabricating a dielectric material from agricultural waste could curtail waste, offering an eco-friendly option for non-recyclable dielectrics in electronics devices such as PCBs, antennas, and sensors, for example. This research highlights the development of a new dielectric material using agricultural waste sourced from pineapple leaves. Pineapple leaves are selected as the primary raw material due to their abundant waste, which is often underutilized, particularly in Malaysia. The dielectric material is fabricated by incorporating pineapple leaves as the base formulation. Then, the fabricated material is characterized by its permittivity value and loss tangent. The permittivity value signifies the material's capacity to absorb or store electromagnetic waves. The analysis includes carbon composition and permittivity values to assess the dielectric potential of these raw materials. Elemental carbon composition is determined through energy-dispersive X-ray (EDX) analysis. The fabricated dielectric material achieves its highest permittivity value at 3.31, with a carbon percentage of 78.05% and an oxygen percentage of 21.95% within 16 runs of the two-level factorial analysis (TLFA) method. These findings indicate that an increased carbon element content enhances permittivity as carbon effectively absorbs and stores electromagnetic signals. Conversely, an increased oxygen element content reduces permittivity due to expanded void space (porous structure), diminishing the material's absorbent or storage capacity for electromagnetic signals. In conclusion, this initial experiment demonstrates that the carbon content of the fabricated dielectric material, derived from waste pineapple leaves, significantly influences its permittivity value.

KEYWORDS

Agricultural waste; Permittivity; Los tangent; Elemental composition; Carbon

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