DESIGN AND FABRICATION OF CELLULOSE-BASED RADIATIVE COOLER FOR ZERO-ENERGY FOOD PRESERVATION

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Food preservation involves treating and storing food to prevent spoilage. Techniques like heat treatment, dehydration, cooling, and fermentation have been developed. Cooling is generally the most adopted method by using refrigerators or freezers. However, it consumes more energy and emits environmental pollutants. Radiative cooling is a sustainable, alternative method using thermal radiation, which removes heat without releasing pollutants. Also, radiative cooling is the process of cooling objects on the earth's surface through the emission of thermal infrared radiation into space via the atmosphere infrared window (IR window). Radiative cooler mostly uses long-wave infrared (LWIR) as its IR window because the maximum infrared radiation transmission through the atmosphere is provided by the LWIR window. The radiative cooler requires high thermal emission in the infrared spectrum (LWIR approximately within 1200 cm^{-1} to 800 cm^{-1}) without visible light absorption. Radiative coolers can designed in several groups of materials such as dielectric multilayer, organic-inorganic composite, porous polymer, and metamaterials. This research aims to design a sustainable and energy-efficient radiative cooling material for food preservation applications. For that, this research used organic-inorganic composite material for fabricating radiative cooling material. As well cellulose was used as an organic matrix and was extracted from water hyacinth aquatic plants. Cellulose has potential as a radiative cooling material due to its ability to absorb infrared light through molecular vibration. However, due to its low solar reflectance, it is not suitable for direct use. For that SiO_2 was used as an inorganic filler to increase the efficiency of the radiative cooler. Initially, 10 g of water hyacinth biomass was taken and treated with 5% NaOH and 5% NaOCl 64% H_2SO_4 solutions to obtain cellulose. 5 g of cellulose was dissolved with 7% NaOH and 12% urea solution and was treated with 2% sodium silicate solution to fabricate cellulose-silica composite material. After Alkali & bleaching treatments, both hemicellulose and lignin were removed from the biomass and a bleached cellulose yield of 57.52% was obtained. 42.48% of the weight was lost from water hyacinth biomass. Stretching of the Si-O and Si-O-Si bonds in the composite material is shown by detectable peaks at 923 cm^{-1} and 1041cm-1. Therefore, the FTIR spectrum corresponds to the material's emissive properties within the LWIR range. These peaks indicate vibrational modes associated with bonds that contribute to the thermal radiation emission. According to this study, the cellulose-silica composite material can be used for fabricating radiative coolers for zero-energy food preservation.

Keywords: *Cellulose, Environmental pollution, Organic-inorganic composite material, Radiative cooler, Zero-energy food preservation.*