THESIS INFORMATION

Title: Research and Manufacture Woodceramic from Cashew Nut Shell Waste

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Abstract

Woodceramic is a wooden product that was named in 1994 by Professor Toshihiro Okabe. The woodceramic is a carbon material which sintered at high temperatures in a non-oxygen atmosphere. Because the material is derived from wood, woodceramic is considered an environment material (eco–material) and making woodceramic is an effective method for treating agricultural waste.

In this thesis, we studied how to synthesize the woodceramic from cashew nut shell waste – a by-product of a cashew manufacturing industry, which leads to 240.000 tons of waste annually. Woodceramic from cashew nut shell waste was sintered from 900 to 1200^{o}C in CO_2 environment. To improve sintering level for final product, we implemented pre-carbonized waste of cashew nut shell waste, examine several component proportions, under several sintering temperatures, as well as apply the hot-press technology during the woodceramic sintering process. Final the woodceramic sample that has the best sintering degree in the research conditions obtained has some technology parameters such as the ratio of carbonated powder/phenolic resin was 1/1.3, the sintering temperature was 900^{o}C. This sample had properties such as the bending strength was 125.93kgf/cm^2, the volume density was 1.95 g/cm^3 and the porosity was 17.44 %.

Aiming to utilize waste of cashew nut shell waste, phenolic plastic and carbon powder being used in the thesis also produced from cashew nut shell waste by liquefied wood technology. Experimental results we obtained through this study (differential temperature analysis, evaluate wood residues, the state of phenolic resin at room temperature, determine chemical composition and calorific value of carbon powder) that showed technology parameters to synthesize phenolic plastic from cashew nut shell waste are as follows: The ratio of phenol/cahew nut shell waste is 2 (with 5% additional catalyst of content phenol being used), reaction at 150^{o}C. The suitable temperature for carbonizing from cashew nut shell waste is 500^{o}C.

In addition, thanks to various analytical methodologies i.e. XRD, RAMAN, XPS, FTIR, SEM, sintering process of the woodceramic has been studied. Thus, the sintering process of woodceramic is a sintering reaction. The sintering mechanism of woodceramic is a liquid phase, a formed liquid phase from phenolic resin materials. During the sintering process, a carbon powder pyrolysis to soft carbon, phenolic resin pyrolysis to hard carbon, woodceramic is a combination of soft carbon and hard carbon.

Examined radiant energy under various wavelengths argues the woodceramic has the same characteristics of thermal radiation as a black body. The emission energy decreased when wavelength increases that indicate the characteristics of thermal radiation of the material in question in far-infrared spectrum. Thus, the woodceramic, synthesized from cashew nut shell waste, could be used in agricultural drying equipment or equipment in medical treatments

The main contribution of thesis

- Successfully sintered woodceramic from cashew nut shell waste at temperatures of 700 - 1200^{o}C. The best samples in the laboratory samples have the following production parameters: The weight ratio of carbon/ phenolic resin powder is 1/1.3, the hot pressing pressure is 0.66 kgf/cm^2 at 900^{o}C in CO_2 environment with a

heating rate of 5^{o}C / min, soaked at 900^{o}C for 60 minutes. This sample had a bending strength of 125.93 kgf /cm^2, a density of 1.95 g/cm^3, and a porosity of 17.44%.

- It has clarified the sintered mechanism of woodceramic from cashew nut shell waste: The sintering process of woodceramic is a sintering reaction. The sintering in the reaction helps to reduce the sintering temperature of woodceramic. The sintering mechanism is a sintered liquid phase. The liquid phase is made of phenolic resin. Woodceramic is composed of a combination of hard carbon (the product of thermal decomposition of phenolic resin) and soft carbon (the product of thermal decomposition of carbon powder).

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