UNIVERSITI TEKNOLOGI MARA

SYNTHESIS AND CHARACTERIZATION OF BIOMORPHIC SILICON CARBIDE FROM WOOD POWDERS PRECURSORS

HUSNA BINTI MD ELIAS

Thesis submitted in fulfillment
of the requirements for the degree of
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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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Name of Student	:	Husna Binti Md Elias
Student I.D. No.	:	2014896352
Programme	:	Master of Science (Mechanical Engineering)-EM750
Faculty	:	Mechanical Engineering
Thesis Title	:	Synthesis and Characterization of Biomorphic Silicon Carbide from Wood Powder Precursors
Signature of Student	:	.....
Date	:	November 2017

ABSTRACT

Biomorphic silicon carbide (SiC) is a novel ceramic material derived from natural wood precursors. The industry has shown growing interest on the fabrication of biomorphic SiC based precursors. Several studies were done on synthesized porous SiC from natural wood blocks. Since wood powders abundantly found as a waste in the wood industry, this research was proposing the uses of wood powders as the precursors. Three types of Malaysian wood powders were used which were Kapur, Dark Red Meranti and Kempas. The transformation process into SiC ceramic consists of 2 main processes which are pyrolysis of a wood precursor, followed by silicon infiltration to convert the carbon template into SiC ceramic. Wood powders were compacted into cylindrical shapes pre-template without any adhesives. During pyrolysis, the pre-template was heated up in Argon gas up to 850°C to produce a porous carbon template. Major weight loss detected during 250°C to 500°C in TGA analysis confirmed the decomposition of the wood's aromatic constituents such as hemicellulose, cellulose and lignin. The amorphous carbon template was infiltrated with molten silicon in an Argon atmosphere at 1500°C and transformed into SiC. Compacted wood powders pre-template produced denser SiC that has a uniform microstructure with a pore size around 1 μm. Even though the pore size was not big enough to encourage better diffusion of Si particles, the variation from 1 to 4 hours of silicon infiltration holding time improves the infiltration behavior. As the Si infiltration holding time prolongs, the density increases and more formation of SiC particles were found. The intensity of SiC XRD peaks increases and became more stable by increasing holding time. Decreases of porosity and increases of mechanical strength were observed in all types of wood samples as the holding time increased. The result found that Dark Red Meranti with 4 hours holding times of infiltration gave the highest density of 2.47 g/cm^3. Maximum compressive strength of 101.5 MPa and hardness value of 920.7 HV are attributed by Dark Red Meranti at 4 hours holding time. Kapur gives 85.2 MPa and 884 HV, while Kempas gives 35.6 MPa and 772.3 HV respectively. The properties of carbon template are crucial to ensure the success of the silicon infiltration process. Dark Red Meranti fulfills the critical value of its carbon template properties in term of porosity, density and pore sizes.

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