（Form6）

博士論文審査結果の要旨

博士論文審査委員会

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氏　　名	Don Kaewdook
論文題目	Development of Woodceramics Originated from Biomass, and their Applications

〔論文審査の要旨〕

本論文は、バイオマスから得られるチャーコールとフェノール樹脂との混合物を真空中で焼成（高温、高圧）することにより得られるウッドセラミックスの新しい使用方法を提案するものである。バイオマスとしては、申請者の出身国のタイで多く排出されるゴムの木やココナッツの殻等を扱い、タイのバイオマス処理にも貢献しようとするものである。今回、新たな使用方法として、①アモルファスカーボン膜作製のためのターゲット材料としての利用、②ウッドセラミックスの電気化学的手法による金属コーティングによる機能化、③ウッドセラミックス複合材料、④オゾン処理によるウッドセラミックスの高機能化を提案している。

予備審査は、2014 年 11 月 10 日午後 5 時より約 2 時間にわたって行われた。「ウッドセラミックスの諸特性が何に依存するのか」といった技術的な質問や本研究のモチベーションが分かりにくい、また、博士論文に多くの誤記や欠落があり、論文のロジックも含めて修正の必要性が指摘されたが、「major revision」を条件に予備審査「合格」となった。

公聴会を含む最終審査は、2015 年 2 月 26 日 13 時より 2 時間にわたり行われた。また、山田純審査委員に向けては、当日の出席が不可となったことから 2 月 27 日 13 時より 1 時間 15 分にわたり審査が行われた。審査委員からは、最終論文が大きく修正が加えられた結果、研究内容やモチベーションが分かり易くなったとう評価が得られ、投票の結果、審査委員全員一致で、「合格」と判定された。ただ、バイオマスを利用した複合材料（上記の③の部分）はウッドセラミックスに直接関係しないというコメントが出され、これに関係する第 6 章は付録(Appendix)とすることとなった。なお、研究業績は、掲載済み論文 1 件、国際会議プロシーディングス 7 件、国内会議発表 5 件である。

論　文　要　旨
Thesis Abstract

(yyyy/mm/dd) 2015 年 01 月 13 日

※報告番号	甲　第　１６９号	氏　名 (Name)	Don Kaewdook

主論文題名　(Title)

DEVELOPMENT OF WOODCERAMICS ORIGINATED FROM BIOMASS, AND THEIR APPLICATIONS

内容の要旨　(Abstract)

The increasing world population causes an increasing consumption of resources and the increased generation of waste, which leads to the need for development of new materials made from renewable resources harmless to the natural environment. Thailand has plenty of such renewable resources since its economy is largely based on agriculture, and biomass residues from crops progressively increase as the Thai government promotes the production of crops and high volume exports. Currently, natural rubber is a plant of economic importance to Thailand. The region is the largest producer and exporter of natural rubber in Asia and Thailand has a top of global market share. The natural rubber wood constitutes a large part of its biomass as rubber trees have a productive life of 20-25 years. Once this period of time has been completed, the farmers need to cut down the old trees for replanting. The large volume of waste and biomass from old rubber trees is a problem that needs to be addressed. To use the biomass waste effectively I focus on woodceramics which were developed in Japan.

Woodceramics (WCMs) is a new technical innovation with superb functionalities and high additional value. WCMs are carbon-based hybrid materials consisting of amorphous and glassy carbon (organic carbon resulting from carbonized wood waste) with porous structure.

In this research, I employed diverse techniques developed in Japan to fabricate WCMs. One objective of this research is to explore the potential to use biomass from natural rubber trees and wastes from coconut shells in Thailand to fabricate WCMs.

These techniques will be environmentally safe and save operation costs to dispose of agricultural wastes.

This study examined the use of biomass charcoal made from carbonized residues of rubber wood and or coconut shell, mixed with phenolic resin and carbonized in a vacuum. The microstructure and physical characterization has been performed by several techniques, namely, X-ray diffraction (XRD), scanning electron microscope with energy dispersive X-ray analysis (SEM/EDX) and mechanical test. The results showed that the high weight ratio of phenolic resin increased compressive and bending strength of WCMs and high carbonization temperature affected the microstructure, surface porosity, density and increasing the purity of the graphite of WCMs.

I have studied three main applications of WCMs fabricated from biomass charcoal originated from rubber tree in Thailand, (1) production of amorphous carbon (a-C) films using woodceramics as a target material, (2) electrochemical deposition of nickel and/or copper on woodceramics and (3) fabrication of eco-composites using biomass charcoal with waste melamine formaldehyde. For production of amorphous carbon (a-C) films, the synthesis of the films onto a silicon wafer as substrate was successfully fabricated by a RF magnetron sputtering method using wood ceramics as a target. The a-C films possess carbon turbostratic structure or amorphous with electron configurations of type sp^2 and sp^3. For electrochemical deposition, in order to improve the compressive strength of WCMs, a metallic film was electrochemically deposited using copper sulfate ($CuSO_4$) and nickel sulfate ($NiSO_4$) solutions. As a result, the compressive strength was increased to 35 MPa and 43 MPa after being deposited in $CuSO_4$ and $NiSO_4$ solutions, respectively. Without this deposition process, the compressive strength was 28 MPa. For eco-composite, they were fabricated using charcoal powder obtained from rubber wood waste, waste melamine formaldehyde resin (WMF) powder and phenolic resin as binder. A mixing ratio of WMF lower than 50 wt.% was used in the fabrication of eco-composites. The highest compressive strength of 35.7 MPa was obtained when the mixing ratio: WMF/Biomass charcoal/Phenolic resin was: 50/30/20.

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