10th Eco-Energy and Materials Science and Engineering Symposium


On December 5-8, 2012
Sunee grand hotel,
Ubon-ratchathani

Organized by

Co-organized by
PREFACE:
Message from the President of
Rajamangala University of Technology Thanyaburi

Rajamangala University of Technology Thanyaburi (RMUTT), in conjunction with Kyoto University, is pleased to host the 10th Eco-Energy and Materials Science and Engineering Symposium (10th EMSES). This international conference is not only giving an opportunity for Thai and foreign researchers to present and discuss their research works and update their expertise but also to initially stimulate the development of research works on eco-energy and materials science and engineering. Our program consists of six research tasks: (1) Energy Technology, (2) Environmental and Social Impact, (3) Nanotechnology and Materials Science, (4) Energy Economics and Management, (5) New Energy technology and (6) Nuclear Technology.

I would like to take this opportunity to express our sincere gratitude to our two distinguished Plenary Speakers for kindly accepting our invitation. I deeply appreciate of the very strong support given by Kyoto University. Thanks to the tireless works of the Organizing Committee, the Technical Program Committee, the invited speakers and paper and poster contributors, and excellent program been assembled to cover a broad spectrum of interesting topic. We warmly welcome you to the 10th EMSES on December 5-8, 2012, Ubon Ratchathani, Thailand.

Numyoot SONGTHANAPITAK, Ph.D.
President of Rajamangala University of Technology Thanyaburi
and Conference Chairman of 10th EMSES 2012
PREFACE:
Message from the Director of
Institute of Advanced Energy, Kyoto University

It is my great pleasure to have the 10th Eco-Energy and Materials Science and Engineering Symposium (EMSES) with Rajamangala University of Technology Thanyaburi (RMUTT) under the long-term collaboration between RMUTT and Kyoto University. The 1st EMSES was held in 2001 in Thailand and the symposium has been expanded in its scientific contents as well as the academic network. I believe that the 10th EMSES gives a good opportunity to all participants to exchange their knowledge and idea to realize eco-friendly energy system in society. I would like to express my welcome to all participants and sincere thanks to the 10th EMSES organizing committee and all supporting organizations to make us having this symposium. I hope that the symposium will be successful and lead to further progress in energy science and technology and also in friendships of participants.

Professor Yukio Ogata, Ph.D.
Director of Institute of Advanced Energy, Kyoto University
PREFACE:
Message from the Former Dean of
Graduate School of Energy Science, Kyoto University
Program Leader,
Global COE “Energy Science in the Age of Global Warming”

I want to express my hearty welcome to all participants of Eco-Energy and Materials Science and Engineering Symposium (10th EMSES). This symposium is aiming the realization of importance of energy and materials technology through the academic, science and technology network among the world communities. The symposium gives an opportunity for researchers to discuss their research works and also to initially stimulate the development of research works on eco-energy and materials science and engineering. Once the cooperation among researchers has been created, the further cooperation work will be developed.
I would like also extend my sincere thanks to all who made the meeting possible, including the 10th EMSES organizers, the SEE forum committee members, and the Japanese Government, JSPS, for their kind support. I am looking forward to seeing you in Ubon Ratchathani, Thailand.

Professor Takeshi YAO, Ph.D.
Former Dean of Graduate School of Energy Science, Kyoto University
and Program Leader, Global COE “Energy Science in the Age of Global Warming”
Message from the Chairperson of 10th EMSES Organizing Committee

Rajamangala University of Technology Thanyaburi (RMUTT), in conjunction with Kyoto University, is pleased to host the 10th Eco-Energy and Materials Science and Engineering Symposium (10thEMSES).

RMUTT has a major mission on encouraging and supporting all areas of research. One of the key reasons is to assist in developing capability in science and technology in order to cope with recent rapid change in this field. We have jointly set up an academic symposium on the 10thEMSES with the perception on the significance of exchanging knowledge and research experiences between researcher in the field of energy, materials technology and environmental science. This symposium is not only giving an opportunity for Thai and foreign researcher to present and discussion their research works and update their expertise but also to initially stimulate the development of research works on eco-energy and materials science and engineering. Once the cooperation among researchers has been created, the closer future cooperation incorporate with joint-research works will be developed. Thus, to support the aforesaid role, the symposium working committee would like to invite you to participate in this academic symposium.

I would like to express our sincere thanks to the organizing committee, participants and contributors for your kind corporation to this symposium. I wish this symposium proceeding will be a useful reference for future scientific research development.

Sommai PIVSA-ART, Ph.D.
Dean of Faculty of Engineering, RMUTT
Director of CoE on Sustainable Energy System (Thai-Japan)
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Dr. Wirachai ROYMARIN
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**10th EMSES 2012**

**Conference Program of 10th Eco-Energy and Materials Science and Engineering**

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<tr>
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**Time**

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<tr>
<td>07:00-09:00 am</td>
<td>Registration</td>
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<tr>
<td>09:00-09:40 am</td>
<td>Opening Ceremony at Taptim Siam 4 Hall</td>
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<td></td>
<td>Assoc. Prof. Dr. Numyoot Songthanapitak, President of RMUTT, Thailand and Chairperson of 10th EMSES conference</td>
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<td>Prof. Dr. Kiyoshi Yoshikawa, Vice President of Kyoto University, Japan Co-Chairperson of 10th EMSES conference</td>
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<tr>
<td>09:45-10:45 am</td>
<td>Keynote Speaker I: Japan Power Generation Mix and Energy Security after Fukushima Nuclear Accident, presented by Professor Dr. Keiichi N. Ishihara, Graduate School of Energy Science, Kyoto University, Japan</td>
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<td>11:00-12:00 am</td>
<td>Keynote Speaker II: Vertical Motions in Greater Bangkok Area after the 2004 Sumatra-Andaman Earthquake from GPS Observations and Its Prediction based on the Geophysical Modelling, presented by Professor Dr. Chaiermchon Satirapod, Chulalongkorn University, Thailand</td>
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<td>12:00-01:30 pm</td>
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<td>New Technology 1</td>
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<td>Prof. Dr. DaeHee Park</td>
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<td>Co-Chair</td>
<td>Dr. Wirachai Romyanin</td>
<td>Dr. Sorapong Pavasupree</td>
<td>Asst. Prof. Dr. Warunee Aranyawatthan</td>
<td>Asst. Prof. Dr. Jakreee Srinonchart</td>
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<td>Prof. Dr. Susumu Yoshikawa</td>
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<td>Dr. Supakij Suttiruangwong</td>
<td>Dr. Nitiwatthi Choosakul</td>
<td>Dr. Surawut Chuangchote</td>
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<td>05:00-06:30 pm</td>
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<td>Dr. Sorapong Pavasupree and Dr. Sumonman Niamlang</td>
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# Conference Program of 10th Eco-Energy and Materials Science and Engineering

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<td>Assoc. Prof. Dr. Thawatch Kerduyen</td>
<td>Dr. Seichi Aiba</td>
<td>Prof. Dr. Takeshi Yao</td>
<td>Asst. Prof. Dr. Somchai Hiranvarodom</td>
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<td>Dr. Leong Yew Wei</td>
<td>Dr. Supaporn Tomson</td>
<td>Dr. Nathabhat Phankong</td>
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<td>Assoc. Prof. Dr. Kawee Sirikulkit</td>
<td>Prof. Dr. Jun Li</td>
<td>Prof. Dr. Hiroyuki Hamada</td>
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<td>Asst. Prof. Dr. Boonrit Prasartkeaw</td>
<td>Assoc. Prof. Dr. Yuji Aso</td>
<td>Dr. Sarocha Charoenvai</td>
<td>Dr. Narongchai O-Charoen</td>
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<td>12:15-13:30 pm</td>
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<td>Environmental &amp; Social Impact 1</td>
<td>Energy Economic &amp; Management 1</td>
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<td>EM02, EM03, EM04, EM07, EM08</td>
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<td>Prof. Dr. Chul-Su Kim</td>
<td>Prof. Dr. Yuichi Anada</td>
<td>Prof. Dr. Keiichi N. Ishihara</td>
<td>Assoc. Prof. Dr. Natha Kuptashrien</td>
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<tr>
<td>Co-Chair</td>
<td>Dr. Winai Chanpeng</td>
<td>Assist. Prof. Dr. Kazumi Yamada</td>
<td>Asst. Prof. Dr. Sommai Pivsa-art</td>
<td>Dr. Boonyang Plangklang</td>
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<td>03:15-04:00 pm</td>
<td>Closing Ceremony at Taptim Siam 4 Hall</td>
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Prof. Dr. Takeshi Yao, Leader of GCOE Program/Professor, Graduate School of Energy Science, Kyoto University

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<th>Time</th>
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<tr>
<td>08:00am-05:00 pm</td>
<td>Excursion</td>
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Surface Treatment of natural fibers with Flexible Epoxy Resin

Napawadee Klomhadya1, Putinun Uawongsuwan2, WeraPorn Pivsa-Art1 and Hiroyuki Hamada3
1Department of Chemical Engineering, Faculty of Engineering, Rajamangala University of Technology Thanyaburi, Klong 6, Thanyaburi, Pathumthani 12110 E-mail: napawadee_k@hotmail.co.th
2Department of Advanced Fibro-Science, Kyoto Institute of Technology, Matsugasaki, Sakyo-ku, Kyoto 606-8585, Japan E-mail: putinunu@kmutnb.ac.th

Abstract— Natural fiber reinforced composites have attracted substantial attention as a potential structure material for low cost applications. However, the incompatibility with polymer matrices was mainly affected by the mechanical properties of composites. In this investigation the possibility of using flexible epoxy as a surface modification for several types of natural fiber was studied. Four different natural fibers consisting of coconut fiber, bamboo fiber, vetiver fiber and silk fiber were treated with flexible epoxy resin. The flexible epoxy resin was dissolved in acetone to reduce the viscosity prior to treatment with natural fiber. The effect of acetone on the surface properties of natural fiber was also considered. It can be seen that the acetone and impurities on the surface of natural fibers were removed by immersion in acetone. The surface treatment efficiency of the flexible epoxy resin on natural fiber surfaces was dependent on the size and surface areas of the natural fibers. The small silk fibers, which resulted in large surface areas can be easily coated by flexible epoxy resin. However, in case of large cellulose fiber, the surface of the treated flexible epoxy was clearly observed at 3, 5 and 10 wt.% flexible epoxy content.

Keywords— Bamboo fiber, Coconut fiber, Flexible epoxy, Surface treatment, Vetiver grass fiber.

1. INTRODUCTION

The use of natural fibers as reinforcement material in composite manufacturing was tremendously increased due to environmental awareness, reduction of non-renewable petroleum resource and growing demand on sustainable product development. Moreover, the various advantages of natural fibers over man-made glass and carbon fibers are low cost, comparable specific tensile properties, non-abrasive to the equipment, reduced energy consumption and bio-degradability. Natural fibers have different origins such as wood, pulp, cotton, bark, nut shells, bagasse, corn cobs, bamboo, coconut, cereal straw and vegetable (e.g., flax, jute, hemp, sisal and rami). These fibers are mainly made of cellulose, hemicelluloses, lignin and pectins, with a small quantity of extractives. The fiber constituents vary depending on their origination. Although natural fiber can offer the resulting composites many advantages, the polar fibers have inherently low compatibility with non-polar polymer matrices. The incompatibility may cause problems in the composite processing such as the agglomeration and unevenly distribution of fiber during compounding processing. Moreover, there is also insufficient wetting of fibers, resulting in weak interfacial adhesion [1-4].

The quality of the fiber-matrix interface is significant for the application of natural fibers as reinforcement fibers for polymer matrices. Both physical and chemical modifications can be used to optimize this interface. The use of different kinds of physical and chemical surface treatment methods leads to changes in surface structure of the fibers as well as to changes in the surface energy. Physical treatments (e.g. plasma and corona discharge) may create a hydrophilic or hydrophobic fiber surface by changing the surface energy. Chemical modification provides the means of permanently altering the nature of fiber surfaces by grafting polymer onto the fibers, crosslinking of fiber cell walls, or by using coupling agents. The coupling agent is a chemical that functions at the interface to create a chemical bridge between the reinforcement and matrix. A variety of silanes (mostly trialkoxysilanes) have been applied as coupling agents in the natural fiber reinforced polymer composites to promote interfacial adhesion and improve the properties of composites [5-8].

S. Thitishnasarn et al. studied the improvement of thermal resistance of natural fibers to facilitate their usage with high temperature thermoplastic by using several thermosetting resin coating on the surface of natural fiber [9]. The onset degradation temperature of natural fibers can be improved by coating with thermosetting resin. In addition, the utilization of flexible epoxy resin coating on jute fabric also improved the mechanical properties of natural fiber reinforced polymer composite [10].

The aim of this work is to explore the possibility of using flexible epoxy resin as the surface modification for several types of natural fibers. Four different natural fibers consisting coconut fiber, bamboo fiber, vetiver fiber and silk fiber were treated with flexible epoxy resin. The effects of treated resin content on the surface of natural fibers were observed to evaluate the coating ability of flexible epoxy resin on different types of fibers.

2. EXPERIMENTAL

2.1 Materials

Four kinds of natural fibers including coconut fiber, bamboo fiber, vetiver grass fiber and silk fiber were supplied from Rajamangala University of Technology Thanyaburi (RMUTT) in Thailand. The chemical composition and fiber size of natural fibers were shown in Table 1. The flexible epoxy resin (grade PB 3600) was supplied by Daicol Chemical, Co., Ltd. Acetone was used for reduced the viscosity of flexible epoxy resin during surface treatment processes.
Table 1. The chemical composition and fiber size of natural fiber

<table>
<thead>
<tr>
<th>Fiber</th>
<th>Cellulose (wt%)</th>
<th>Lignin</th>
<th>Fiber aspect ratio (min: max: average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut fiber</td>
<td>30.49</td>
<td>43.0</td>
<td>8.6-49.8(26)</td>
</tr>
<tr>
<td>Bamboo</td>
<td>60.80</td>
<td>32.2</td>
<td>2.34-8(9.5)</td>
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<tr>
<td>Vetiver grass</td>
<td>72.64</td>
<td>17.3</td>
<td>2.2-6(3.8)</td>
</tr>
<tr>
<td>Protein fiber</td>
<td>Fibroin</td>
<td>Sericin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>70-80</td>
<td>20-30</td>
<td>2-3</td>
</tr>
</tbody>
</table>

2.2 Surface Treatment by Flexible Epoxy Resin

The flexible epoxy resin was dissolved in acetone for reducing the viscosity prior to treat with natural fibers. The ratio between natural fibers, flexible epoxy and acetone was shown in Table 2. To evaluate the effect of acetone on the surface of natural fibers, each fiber was immersed in acetone for 10, 30 and 60 minute, respectively. The treated natural fibers were first dried at room temperature for 24 hours. Then the treated natural fibers were second dried in vacuum oven at 80°C for 24 hours.

Table 2. The ratio of fiber and Flexible epoxy solution.

<table>
<thead>
<tr>
<th>Fiber</th>
<th>Flexible epoxy treatment</th>
<th>Fiber ratio</th>
<th>Flexible epoxy (g)</th>
<th>Acetone (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut fiber, Bamboo fiber, Vetiver grass fiber, Silk fiber</td>
<td>1</td>
<td>10</td>
<td>0.1</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>10</td>
<td>0.3</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>10</td>
<td>0.5</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>1.0</td>
<td>200</td>
</tr>
</tbody>
</table>

2.3 Morphological Observation

A scanning electron microscope (JEOL, JSM 5200) was used for the observation of fiber surface. The untreated and treated natural fiber were attached on the copper stubs and coated with gold to avoid an electrical charging.

3. RESULTS AND DISCUSSIONS

3.1 Effect of acetone washing

The surface of natural fiber contains cellulose, lignin and many impurities such as wax and fatty. Lignin is a cementing agent that holds fiber ultimate together in bundle, which create poor adhesion between matrix and fiber. The role of the acetone using in this work is mainly to reduce the viscosity of the flexible epoxy resin. Therefore, the effect of acetone on the surface property of natural fiber was also considered. The surface characteristic of natural fibers after immersed in acetone at different period are shown in Fig. 1. The fibers were separate to two group as cellulose (coconut fiber, bamboo fiber and vetiver grass fiber) and protein fiber (silk fiber).

In the case of cellulose fiber, it can be seen that waxes and impurities at the surface of vetiver grass fiber, coconut fiber and bamboo fiber were removed by immersed in acetone. However, in the case of silk fiber, acetone washing could remove only impurities, and no effect on fibroin and sericin.

In addition, the effect of immersed time was studied. The effect of immersion time of natural fiber in acetone were inconsiderable change the surface characteristic of all natural fibers.

3.2 Effect of flexible epoxy resin

The surfaces of the natural fiber treated with flexible epoxy resin are shown in Fig. 2. The surface of flexible epoxy treated silk fibers was clearly observed at any flexible epoxy content. This reason for this could be that silk fiber was consisted of a number of small fibroin fibers, which resulted in large surface area during the treating process.

In the case of cellulose fiber such as bamboo fiber, vetiver grass fiber and coconut fiber, the flexible epoxy treated was slightly observed on the fiber surface at low flexible resin content. This may resulted from the larger fiber diameter of the cellulose fiber when compared with silk fiber. However, the surface of flexible epoxy treated was clearly observed at 3, 5 and 10 wt.% flexible epoxy content.

4. CONCLUSION

This study was focused on the using of flexible epoxy resin as the surface treatment for natural fiber. The effect of flexible epoxy content on the changing of surface characteristic of four different natural fibers was observed from SEM micrograph. In order to clarify the effect of acetone which used for reduce the viscosity of flexible resin, the natural fibers were immersed in acetone at different period of time. The impurities on the surface of natural fiber were removed by washing with acetone.

After treatment the surface of natural fiber were observed. It appears that, the surface treatment efficiency by flexible epoxy resin on natural fiber surfaces were dependence on the size and surface area of natural fibers. The small silk fibers, which resulted in large surface area can be easily coated by flexible epoxy resin. However, in case of large cellulose fiber, the surface of flexible epoxy treated was clearly observed at 3, 5 and 10 wt.% flexible epoxy content.
Fig. 1. The surface of natural fiber after acetone immersion.

REFERENCES


Fig. 2. The surface of natural fiber compared between acetone washed and flexible epoxy treated.
Poly(lactic acid) and Poly(butylene succinate) blend Fibers Prepared by Melt Spinning technique

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Abstract— In this study, biodegradable polymer blend fibers were prepared by melt spinning technique. Poly(lactic acid) (PLA) and poly(butylene succinate) (PBS) were blended in a twin screw extruder at various contents of PBS at 0-50 wt%. PLA/PBS blends were melt spun using a single screw extruder equipped with multifilaments spinnerette. The effect of PBS contents on morphology, thermal properties, and mechanical performance of PLA/PBS blend fiber was investigated by scanning electron microscope (SEM), differential scanning calorimetry and tensile testing. SEM micrographs indicated that the addition of PBS at 10 wt% showed miscibility of PLA/PBS blends while the other contents of PBS exhibited phase separation of the blends. The incorporation of PBS affected on the declination of crystallinity in the blends. It can be noted that the addition of PBS could enhance the elasticity of PLA/PBS blend fibers.

Keywords— poly(lactic acid), poly(butylene succinate), melt spinning, miscibility, crystallinity.