

receive their education in the United States. It is highly probable that most students would attend MSU for a master's degree, a period of from 24 to 30 months. In some cases the students might be motivated to pursue a doctoral degree. In this case, the period of time could last up to 60 months. It is reasonable to expect that in return for their participation in this program, the students would be required to return to their home countries for at least a period of time equal to the time they've spent at MSU. That would insure that there is effective technology transfer between MSU and their home country.

ICEP Degree Program

- MSU will provide advanced degree instruction in polymers and biopolymer composite materials, processing and manufacture,
- MSU will provide business coursework and instruction in entrepreneurship, and setting up and running businesses
- MSU will provide students with opportunities for interactions with corporations seeking global development



The governments of developing countries might consider a plan such as this to be a worthwhile investment and provide some or all of the funds to support their students while at Michigan State University if they are able. Alternatively, assistance could be sought from the United Nations (UNEDO), the World Bank, Foundations, or other international funding sources to provide some or all of the financial assistance for funding for a program such as this.

Expected Outcomes: This program would educate students in both the science and technology of composite materials along with teaching them entrepreneurship and business skills. Our native MSU students would benefit through the experience of working with engineers from developing countries. The off-shore companies that result from this program would contribute to international trade, open new markets for biocomposite materials and

assist the developing countries in providing new manufacturing opportunities for job creation, infrastructure expansion and increased global commerce.

Costs and Sources of Support: The cost to support a full time graduate student including tuition and living expenses is ~\$30,000 per year. The capacity of the ICEP program at steady state would be about 15 full-time students per year. The beneficiaries of this program are expected to be the students who participate, their home countries, US industry, the industrialized countries of the world and Michigan State University. While MSU would be expected to provide in-kind support for this program, the major share of the funds would be expected to come from the home countries, US industry, Foundations and the United Nations.

ICEP Degree Program - Eligible Students

- Students with undergraduate degree
 - chemical, materials or mechanical engineering
 - also in chemistry, physics or materials science
 - students can speak, read and write in English
- At the conclusion of their MS degree
 - students would be required to return to their home countries
 - either set up new businesses to produce polymer composite materials,
 - or be employed by existing companies and provide new commercial opportunities to these firms in composite materials and processing
- Duration of the MS stay at MSU would be 24 to 30 months
- Qualified students eligible to pursue a doctorate degree could be expected to require an additional 24-36 months



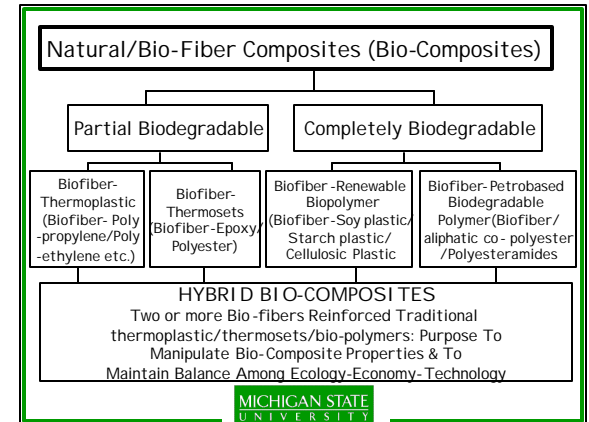
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International Cooperative Education Program (ICEP) in Polymer BioComposite Materials Processing and Manufacturing

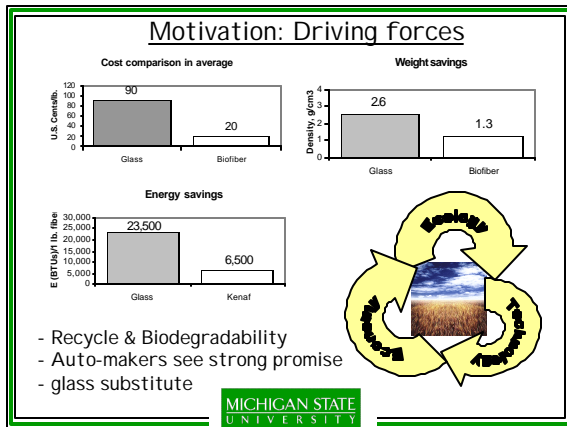
Polymer composite materials are materials for the future. They are lightweight, have excellent mechanical properties, and potentially low in cost. In the United States now over 51 percent of all manufactured goods



contain some polymers, plastics, or polymer composite materials. At the same time, there is also a desire to incorporate into polymer composites, more materials made from natural resources rather than from petroleum resources. The Composite Materials and Structures Center in the College of Engineering at Michigan State University has been conducting research on polymer composites processing for the last eight years under National Science Foundation sponsorship through the MSU State/Industry/University Cooperative Research Center. As part of this effort a large industrial consortium of US based industry sponsors composite materials and processing research.

The focus of our research has been on developing new processing methods for the manufacture of composite materials. There is a

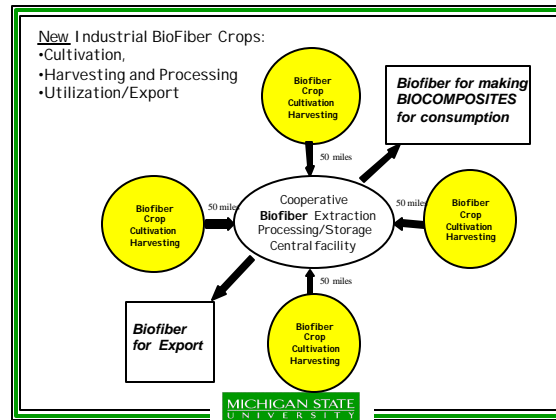
strong, growing trend toward substitution of natural materials into polymer composites. Recent developments have shown that chemicals from plants can be used as precursors to manufacture polymers used in these composites. Likewise natural fibers from plants are effective as reinforcements for polymers. Their properties can rival those of glass fibers. The added advantage is that cellulose-based materials are lower in density, recyclable, sequester carbon dioxide, are potentially lower in cost, and are grown everywhere.



Our center has taken on a new direction that strongly emphasizes the ability to utilize chemicals and reinforcements from plants and natural minerals in the next generation of composite materials. This includes the utilization of sugar and starch materials from plants as well as plant fiber and cellulose. Fibers such as jute, flax, hemp and hennequen are or have been incorporated into polymer composites with beneficial results.

Agrarian-based societies could develop industry around the cultivation and harvesting of plants for polymers and composite materials at the basic level. With some additional training, water-based chemical processing methods could be introduced to produce value-added chemicals and constituents from plants. In the short term, these materials could be exported to large manufacturing corporations around the world. Over the longer-term these materials themselves could provide the foundation for native industry and greater internal consumption of finished composite materials. This technology could also provide material for export and incorporation in

manufactured goods in the United States and other countries or serve as the foundation for



manufacturing of basic transportation and housing needs within these countries themselves.

In order for such a development to take place, there has to be a combination of human, plant, and financial resources available. This proposal seeks to address that issue.

Proposal: Michigan State University can provide an advanced technical education to qualified students from developing countries. We seek graduate students to participate in our composite materials and processing research and

that can engage in international commerce. We have developed at MSU several new courses on polymers, polymer composites and their processing, manufacture and design that are taught to undergraduate and graduate engineers. Our industrial sponsors are eager to see new sources of materials and composites arise in the developing countries. We would like to bring to our center, students having an undergraduate degree primarily in engineering but also in chemistry, physics, or materials.

We propose not only to teach these students about composite materials, processing

ICEP Degree Program

- Award Scholarships to eligible ICEP students to...
- Attend MSU in residence to pursue a MS degree in either Chemical, Mechanical, or Materials Science and Engineering
- Emphasis on polymers, bioresource materials and biocomposite materials and processing
 - composite materials
 - their processing and manufacture
 - utilizing bio and renewable resources
 - business courses emphasizing business start-up, new product introduction, and international commerce.

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ICEP Degree Program

- MSU is a world renowned center for polymer composite materials.
- faculty teach several courses on polymers, polymer composites and their processing, manufacture and design
- taught to undergraduate and graduate engineers
- industrial sponsors eager to see new sources of materials and composites arise in the developing countries

MICHIGAN STATE UNIVERSITY

receive an education not only in polymer composite materials, their processing and manufacture, but also in business and commerce particularly in starting and running a company

and manufacture but also to provide additional business coursework and instruction in entrepreneurship, and setting up and running businesses that could develop commercial interactions with American and global corporations.

After education at MSU, ICEP students, would return to their home countries and either set up new businesses to produce biobased chemicals and materials, or be employed by existing companies in their home countries and provide new direction and opportunities for these firms as a result of their education in biocomposite materials and processing. At the same time they would have the benefit of their experience in the United States to assist them in developing interactions with U.S. firms for marketing and commerce.

In order to make a plan such as this operate effectively, third-party funds would have to be provided to support the students while they