

Introduction to Composite Materials for Engineers and Technicians

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Abstract:

This module incorporates a powerpoint presentation that explains to engineers and technicians what composites are and what they need to understand about composites and their applications.

Module Objective:

To provide a one-lecture introduction to composites that can be used to introduce the subject to students at the high school or college level. This may be used in conjunction with other composites modules or as an introduction to a course on composites

Student learning objectives:

- To provide the student with an introductory understanding of composites manufacturing processes
- To provide students with an understanding of advanced composites used in modern (within the last 10 years) manufacturing industries such as aerospace, automotive and renewable energy
- To provide students with knowledge of composite material selection, performance and manufacturing and applications

MatEd Core Competencies Covered:

- 7C Describe the general nature of composite materials
- 11A Describe the structure and advantages of composite materials
- 11B Explain basic processing procedures for composite materials

Key Words: Advanced, Composites, Materials, Engineers, Modern

Type of Module: Introductory powerpoint presentation

Time Required: One period for introductory powerpoint

Pre-requisites: Some fundamental knowledge of material science

Target Grade Level: Introductory college or advanced high school science and technology courses

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List of equipment needed: Powerpoint projections system

Curriculum overview and Instructor Notes:

Composites incorporate two or more materials combined to provide physical properties and attributes that are superior to either of those materials alone. They are increasingly used as modern manufacturing and building materials and there is a rapid growth in their use in transportation (bicycles, motorcycles, cars, trucks, RVs, planes, trains, and snowmobiles), infrastructure (bridges, paving, water and sewage systems, piping), sporting equipment (skis, snowboards, tennis rackets, running shoes, camping gear, boats) packaging and many other products that we design and use every day. Composites are corrosion resistant, high strength, easy to manufacture and have many other advantages over conventional materials.

Engineers today need to understand the physical properties of composites as well as how to select the correct ones for a given application, they need to understand the actual application of composites so that they are knowledgeable incorporating them into the design and manufacturing of tomorrow's products. Technicians need to understand composites processing and manufacture. The need for this understanding is urgent, having a sustainable component; as we must design lighter, longer lasting, more fuel efficient modes of transportation as well as lighter and easier to construct building products. These products produce less waste, sometimes can be recycled and lower our carbon footprint.

The following notes accompany the powerpoint slides:

Slide 1- the plane in the photo is an unmanned drone (piloted out of Los Angeles from the ground) for reconnaissance work and is has a fuselage and wing segment built primarily of advanced composites.

Slide 2- this is an overview of the history of composite with some comments on an introductory level.

Slide 3- the picture illustrates the extensive use of composites in new commercial aircraft and also identifies the global extent of the vender network. The slide also

identifies various product areas and industries where composites play an increasing roll. Slide 4 is a continuation of this.

Slide 5-Lists some pros and cons of composites and the photo was taken at an air show in Wichita depicting a Lincoln Navigator resting on top of the wing of a four seater composite wing (now the Cessna 400), thus illustrating the strength in a composite wing.

Slide 6-Shows some of the 'needs' of having the course developed for Industry, students and colleges. The slide shows a mold or tool with a lay up with a joint in it.

Slide 7-Shows some of what some of the industry connections can do to enhance the course.

Slide 8-Shows some of the companies that I gathered ideas and info from and then some of the ideas are listed. The graph shows the extensive growth that composites usage has undergone in the commercial aircraft industry.

Slide 9-Is an outline of the course listing some of the main topics covered. The graphics shows a sandwich type composite layup with honeycomb center reinforcement.

Slide 10-Discusses some of the items that are incorporated in the lab that is developed. The photo shows a prepreg hand layup of a molded part being manipulated with a heat gun.

Slide 11- Lists some of the equipment used and the photo is of some of the hand tools used.

Slide 12- Touches on safety issues and the photos show various gloves used as personal protective equipment when handling composite materials.

Slide 13- Lists some of the materials used in the labs and the photo shows three samples of woven composite reinforcement cloth.

Slide 14- Shows a wet hand layup and then a vacuum bagged part.

Slide 15- Provides a prompt on inspection of composite parts with visual an then a sketch of a delamination.

Slide 16- Is a chart of various defects that can occur in composite manufacture and where in the process they are likely to occur.

Slide 17- Is a prompt to discuss the incorporation real industry problems into the course and some of the testing that industry is currently doing when using composites. The sketch shows the concept of 'clocking' ply orientations when using composite reinforcements.

Slide 18-Shows some of the assessment ideas used in the course that were originally put forward by Cerritos Community College when they developed their composites course.

Slide 19-same.

Slide 20-Emphasizes incorporating the team concept into the course and learning process. The sketch shows the typical symbol used for 'clocking' on composite blueprints.

Slide 21-Shows references for this work

Module procedure:

Review the attached PowerPoint slides with the class, followed by discussion.

References:

Refer to the last slide of the powerpoint

Evaluation Packet:

Student Evaluation Questions (discussion or quiz):

- 1) What characteristics are unique to advanced composites?
- 2) List some of the industries and products that are utilizing advanced composites and discuss why they are using them.
- 3) Identify some safety concerns that are unique to manufacturing with advanced composites.
- 4) What are some of the defects that can arise when working with advanced composites and where in the process are they most likely to originate?
- 5) What is the purpose of clocking the reinforcement material in an advanced composite layup?

Instructor evaluation questions:

- 1) What grade level was this module used?
- 2) Was the level and rigor of the module what you expected? If not, how can it be improved?
- 3) Did the class generate interest among students?
- 4) Please provide input on how this module can be improved, including comments or suggestions concerning the approach, focus and effectiveness.

Course evaluation questions (for the students):

- 1) Was the instructor's explanation comprehensive and thorough?
- 2) Was the instructor interested in your questions?
- 3) Was the instructor able to answer your questions?
- 4) What was the most interesting thing that you learned?

Author Bio: Joe Stuart has 30 yrs industry experience as design engineer, field engineer, marketing engineer, metallurgist, owned machine shop/fab business for 4 yrs, Professor for 5 years- teaching materials, Director of Manufacturing Program @ OIT, sustainability chair, rancher raising beef, trout, and wine grapes for 32 years, geophysicist for 4 years working on oceanographic projects worldwide.