

DEPARTMENT OF MECHANICAL ENGINEERING

ME 440 MATERIALS FOR AGGRESSIVE ENVIRONMENTS

FALL 2006

Section 1 - MWF 10:10 a.m. - 11:00 a.m., 301 Riggs

Instructor:

Dr. Mica Grujicic, Wilfred P. and Helen S. Tiencken
Professor of Mechanical Engineering
Office: 241 EIB, Tel. 656-5639, e-mail: mica@ces.clemson.edu

Textbook:

None

Reference Material:

Geoff Davies, Materials for Automobile Bodies
Butterworth-Heinemann, Boston, MA 2003
Various technical reports and journal articles
Hand-out material provided by the instructor
World-Wide-Web downloadable material recommended by the instructor.

Goals and Objective:

To provide the student with:

1. An understanding of the objectives and requirements of design engineers, and the processing expectations of technologists involved with materials selection and component manufacture (the automotive process chain);
2. Properties relevant to the selection and use of automotive materials, together with essential features of their preparation and processing;
3. The need for material consistency which is a major factor in achieving maximum utilization in production;
4. The need for thorough rehearsal of any new aspect of materials technology before implementation is even considered;
5. The evolutionary principle - new technology is gradually assessed and introduced in low volume applications, before introduction to high production vehicle models;
6. The need for easily digested explanations of materials 'pros and cons' to help the structural engineer in his/her choice and assess implications of associated treatments which may not be immediately apparent to the non-material specialist;
7. An understanding of price extras applying to many apparently similar materials options and treatments when trying to anticipate the effects of changing specifications on the manufacturing processes;

8. Increasing complexity of the vehicle materials technology over the past twenty years; and

9. Case studies which illustrate the development of various design technologies and the experience of key automotive OEMs such as BMW (body design/environmental aspects) and Volvo (safety engineering) and demonstrate the synergies achieved through the use of advanced materials.

Class policy:

My expectations of you are similar to those you have of me. I assume that you will attend class, that you will be on time and prepared, and that we will maintain a professional, courteous relationship. Policy on academic dishonesty is that stated in the Clemson University Undergraduate Announcements. Students may discuss approaches to the homework problems, however, all work turned in for grading is expected to be the individual's effort, not a group or joint effort! Simple copying or paraphrasing is not allowed.

Homework:

Representative problems will be assigned for all topics. Homework is due one week after it is assigned. Solutions will be placed on reserve in the library after the problems are due, and therefore, late homework will NOT be accepted. Since each student has ready access to computers and printers, all work submitted for grading MUST be produced on a computer word processing system and printed via a computer printer. Homework MUST be submitted in a hard-copy form. No electronic submission of the homework is allowed.

Semester Tests:

Two 75-minute, closed-book, close-notes tests will be given. Oral make up tests will be given ONLY for DOCUMENTED personal illness or immediate family emergency.

Grading:

Final grades for this course will be determined according to the following percentages:

Homework	30%
Semester tests (35% each)	70%

Grades will be assigned as following: A - 90 or higher; B - 80 to 89; C - 70 to 79; D - 60 to 69; F - 59 or lower.

Prerequisites:

“Any course taken which will later be used as a specified prerequisite for any ME or EM course must be completed with a minimum grade of "C".” All required 300-level ME and EM courses are prerequisites for ME440.

Test Dates:

Wednesday, September 27, 2006 - Review for Test 1

Friday, September 29, 2006 - Test 1

Wednesday, November 15, 2006 - Review for Test 2

Friday, November 17, 2006 - Test 2

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Topics to be Covered

1 Introduction

1.1 Overview of content

1.2 Materials overview

1.3 General format of presentation

1.4 Introduction to body architecture and terminology

2 Design and material utilization

2.1 Introduction

2.2 Historical perspective and evolving materials technology

2.3 Finite element analysis

2.4 One manufacturer's approach to current design

2.5 Panel dent resistance and stiffness testing

2.6 Fatigue

2.7 Alternative body architecture

2.8 Integration of materials into designs

2.9 Engineering requirements for plastic and composite components

2.10 Cost analysis

2.11 Learning points from Chapter 2

3 Materials for consideration and use in automotive body structures

3.1 Introduction

3.2 Material candidates and selection criteria

3.3 Aluminum

3.4 Magnesium

3.5 Polymers and composites

3.6 Learning points from Chapter 3

4 The role of demonstration, concept and competition cars

4.1 Introduction

4.2 The BL Energy Conservation Vehicle (ECV 3) and aluminum structured vehicle technology (ASVT)

4.3 ULSAB and ULSAB 40

4.4 Concept cars

4.5 Competition cars

4.6 Key learning points from Chapter 4

5 Component manufacture

5.1 Steel formability

5.2 Aluminum formability

5.3 Manufacture of components in magnesium

5.4 Production of polymer parts

5.5 Learning points from Chapter 5

6 Component assembly: materials joining technology

6.1 Introduction

6.2 Welding

6.3 Adhesive bonding

6.4 Mechanical fastening

6.5 Learning points from Chapter 6

7 Corrosion and protection of the automotive structure

7.1 Introduction

7.2 Relevant corrosion processes

7.3 Effective design principles

7.4 Materials used for protection of the body structure

7.5 Empirical vehicle and laboratory comparisons

7.6 An introduction to electrochemical methods

7.7 Learning points from Chapter 7

8 Environmental considerations

8.1 Introduction

8.2 Effect of body mass and emissions control

8.3 Life cycle analysis (LCA)

8.4 Recycling and ELV considerations

8.5 Hygiene

8.6 BIW design for safety

8.7 Learning points from Chapter 8

9 Future trends in automotive body materials

9.1 Introduction

9.2 Factors influencing material change in the future – trends and requirements

9.3 Combined effect of above factors on materials utilization within 'expected' and 'accelerated' timescales

9.4 Learning points from Chapter 9