Materials Selection Class Project

3.080 Economic and Environmental Issues in Materials Selection

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Overview

- Objective: Identify promising candidate materials for a given design
- Consider:
  - Design requirements (mechanical, thermal, …)
  - Shape (as necessary)
  - Processing
- Deliverables for Tuesday, 10/25:
  - Function, Constraints, Objectives, and Free Variables
  - Possible material Index/Indices, showing calculation method and/or source(s)

Deliverables

Presentation: 11/1, 15 minutes, done as a group

- **Background on design**
- **Describe material selection process**
  - **Function, objectives, etc.**
  - **Material Indices**
  - **What materials were eliminated? Why?**
    - ***Do these indicate other criteria that should be included in the analysis?***
  - **How were multiple objectives or constraints balanced?**
  - **Show outputs from CES software**
- **What 3-5 materials were identified as promising?**
  - **Summarize pertinent material properties and processing characteristics**
  - **Discuss what you think are the strengths and weaknesses each candidate**
  - **How do these compare with materials used in actual designs?**
- **Describe any other information or analysis you would need to make a final selection**

Write-up: 3-5 pages, done as individual

- **Cover same topics as above**

Topic #1: Automotive Hoods

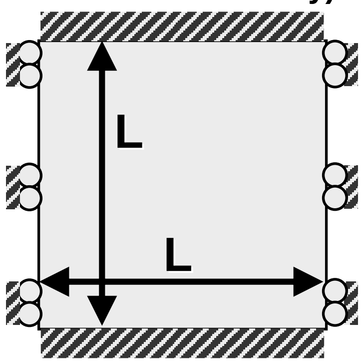
Background

Automotive hoods must simultaneously meet the requirements of mechanical loading and mass production in a cost-effective manner. Hoods typically consist of two main components: an outer (the surface seen on the outside of the car) and an inner, which is a structure that acts to provide stiffness to the hood and can have some complex forming requirements. The outer and inner are nearly always made from the same material.

Modeling tips

Consider the hood as a square, thin, flat plate that is rigidly fixed on two sides and simply supported on the other two sides.

Equations for stiffness and stress can be found in Marks' Handbook (available online from the library).



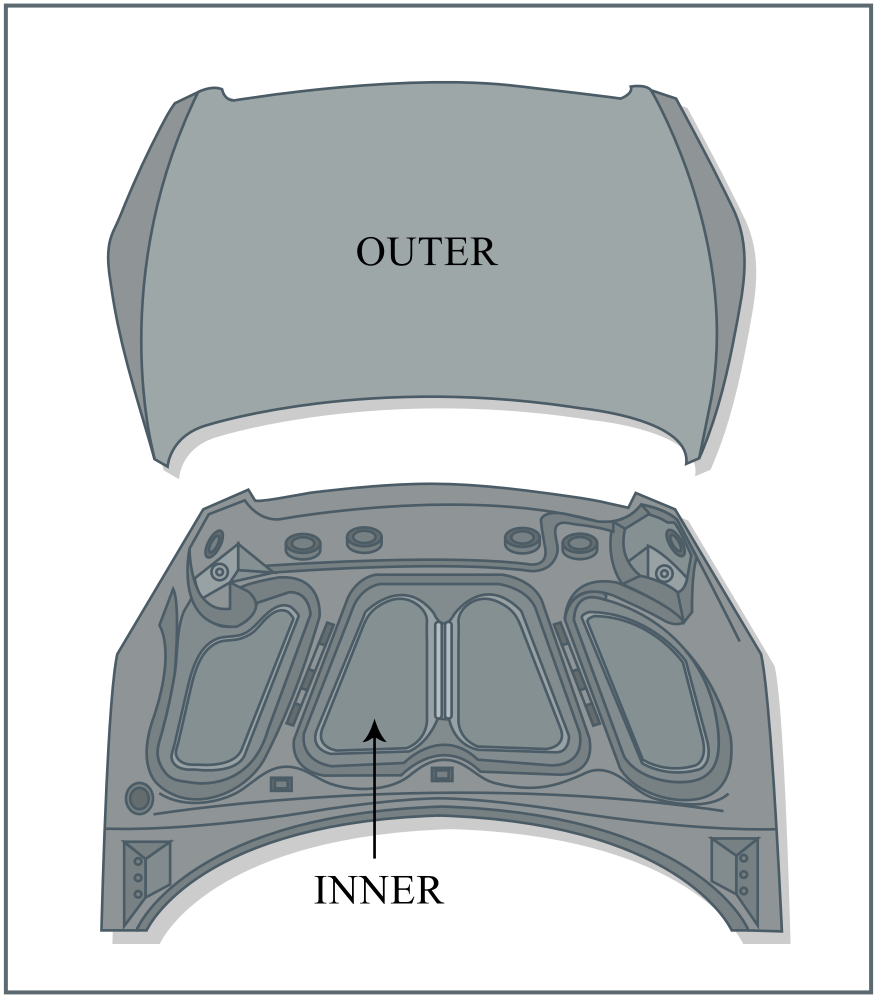


Figure by MIT OCW.

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Topic #2: Aperture Grill for CRTs

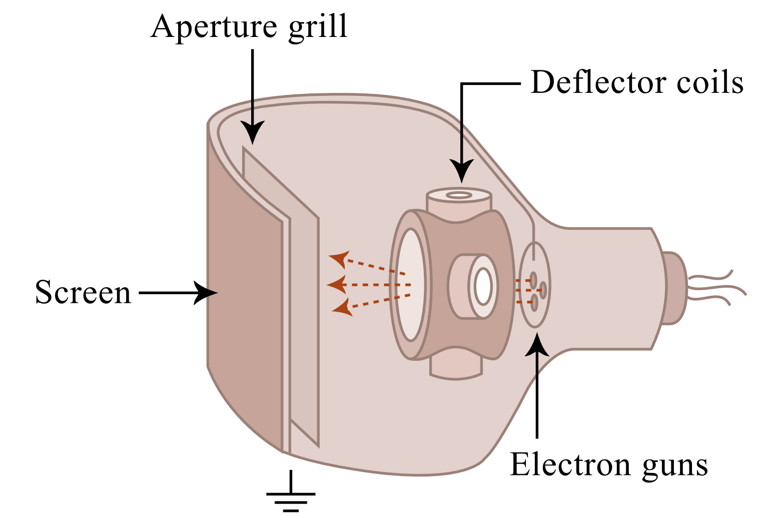


Figure by MIT OCW.

Background

Two types of cathode ray tube (CRT) dominate the computer monitor and television marketplace. In the older technology, color separation is achieved by using a shadow mask: a thin metal plate with a grid of holes that allow only the correct beam to strike a red, green or blue phosphor. A shadow mask can heat up and distort at high brightness levels ('doming'), causing the beams to miss their targets, and giving a blotchy image.

To avoid this, the newest shadow masks are made of Invar, a nickel alloy with a near-zero expansion coefficient between room temperature and 150°C. It is a consequence of shadow-mask technology that the glass screen of the CRT curves inward on all four edges, increasing the probability of reflected glare.

Sony's 'Trinitron' technology overcomes this problem and allows greater brightness by replacing the shadow mask by an aperture grill of fine vertical wires, each about 200 μm in thickness, that allows the intended beam to strike either the red, the green or the blue phosphor to create the image. The glass face of the Trinitron tube is curved in one plane only, reducing glare.

The wires of the aperture grill are tightly stretched, so that they remain taut even when hot – it is this tension that allows the greater brightness.

Requirements

- Wire thickness and spacing specified
- Material must be electrically conducting to prevent charging

Modeling Tips:

There is an elastic strain on the wire caused by pretension, ε_{pt}, but there will also be a strain due to thermal expansion, ε_{th}. The strain from thermal expansion cannot exceed the elastic pretension strain.

Topic #3:
C-Clamp for Electronics Processing

Background

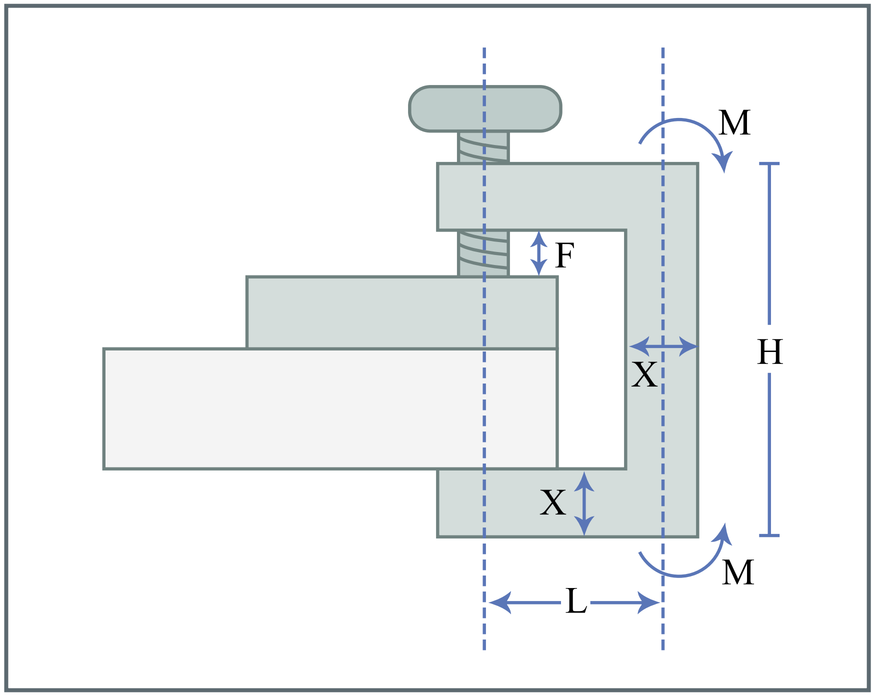
A C-clamp is required for processing of electronic components at temperatures up to 450 ºC. It is essential that the clamp have low thermal inertia so that it reaches temperature quickly, and it must not charge-up when exposed to an electron beam. The approximate time *t* it takes a component of thickness *x* to reach thermal equilibrium when the temperature is suddenly changed (a transient heat flow problem) is:

$t = x^2/2a$ where *a* is the thermal diffusivity.

The time to reach thermal equilibrium is reduced by making the section *x* thinner, but it must not be so thin that it fails in service.

Modeling tips

Consider the portion of the C-clamp with length *H* as a beam with a square cross-section of width *x* and depth *b*. It is subject to a bending moment that is generated by the force *F*.



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