MMC Hammer

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Overview

- What are MMCs?
- Design Parameters
- Project Goals
- Setup Diagram
- Device Picture
- Prototype Design
- Testing and Imaging
- Projected Work Schedule
What are MMCs?

- **Metal Matrix Composites**
- **Benefits:**
  - High modulus from ceramic
  - High toughness from metal matrix
  - Lower density leads to high specific strength
- **Methods of Fabrication:**
  - Stir Casting
  - Pressure infiltration (gas, mechanical, centrifugal)
- **Ceramic – metal reactivity**
  - Can be optimized to yield strong bonding between components
Design Parameters

\[ P = ( \_ \_ ) * ( \_ \_^2 ) * ( z_2^2 - z_1^2 ) \]

- \( P = \) pressure,
- \( \_ = \) density of metal
- \( \_ = \) angular frequency,
- \( z = \) horizontal position

\[ P_{\text{th}} \propto ( \gamma * V_{f,c} ) / ( D_c * V_{f,m} ) \]

- \( \gamma = \) surface energy of the liquid metal
- \( V_{f,c} = \) volume fraction of ceramic
- \( V_{f,m} = \) volume fraction of the metal
- \( D_c = \) size of ceramic particles
Project Goals

- **Materials choice**
  - Metals: Tin-lead, Aluminum alloy
  - Ceramics: SiC, TiC, WC, Al₂O₃

- **Part production**
  - CAD design
  - Mold fabrication and filling
    - Investment casting with a ceramic mold
    - Steel machined mold
    - Ceramic preform

- **Volume Fraction**
  - Maximization through size distribution of ceramic particles
  - Gradation of properties through localized ceramic type and density variations
Setup Diagram

Above: Top View

To Left: End View
Prototype Design

- Part of an engine
  - Piston
  - Crank shaft
- Propeller
- Hammer head
- Steel-toe boot
- Armor
- Bicycle crank
- Golf club
- Tools

Koczak, "Structural Composites," and "Thermal Composites"
Testing and Imaging

● Testing Mechanical Properties
  - Specific strength
  - Hardness
  - Impact testing
  - Fracture resistance

● Microstructure Analysis
  - SEM
  - Optical Microscopy
Projected Work Schedule
Works Cited


