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**Short Course – Topics / Outlines**

***Materials: structure- properties*** *–* Crystal structure / bonding: *metals, polymers, composites – introduction!*

***Defect generation & storage:*** How various material classes respond to deformation

***Mechanical Behavior***

Definitions: stress-strain, elastic, plastic, hardening, ductility, fracture toughness

Defects and strengthening – dislocations and twins,strain hardening, effect of grain size, anisotropy, alloying, precipitation hardening, cold work

How it’s quantified – quasi-static, intermediate-rate, split-Hopkinson pressure bar (SHPB), gas launchers

How materials differ in their response to changes in loading rate, temperature, stress state: Metals, alloys, polymers, metallic composites, energetics, and brittle solids examples

**Split-Hopkinson Pressure Bar:**

• Historical background on the technique

 • Principles of the SHPB

 • Theory of the SHPB

 • Practical Aspects of the SHPB

* Calibration
* Pulse Shaping
* Sample Design – metallic / ceramics
* Test set-up
* Stress-state equilibrium
* Testing as a function of Temperature

• SHPB in Tension

• Wave Dispersion in SHPB

• Limitations of the SHPB

***SHPB Testing of “Soft” Materials***

 **•** Background in Issues with SHPB testing of “soft” materials

 • SHPB testing of soft materials – examples

 • SHPB testing of energetics

 • SHPB testing of reactive materials

 • Considerations for SHPB – pressure bar materials selection

 • SHPB Testing of Polymers / soft / porous materials

 • Low Impedance Metallic Pressure Bars

 • Stress-state Equilibrium issues of Soft Materials

 • Sample Size Effects

 • Temperature testing of Soft Materials

 • Test Sample Preparation

***Constitutive modeling and Model Validation:***

• Material strength models: Johnson-Cook, Zerilli-Armstrong, MTS – strengths / weaknesses of each

• Stress-Strain data – to constitutive models

• Taylor-Cylinder Testing – multiple material examples / modeling

• Dynamic Tensile Extrusion – examples – temperature effects /modeling

• Compact Forced Simple Shear (CFSS) – shear data / modeling

• Damage characterization – insights into modeling damage evolution and fracture

***Response of materials to shockwave loading* – Effects on Post-Shock Mechanical Behavior**

**•** What is a shockwave – How does it evolve?

**•** Experimental techniques for shock-loading studies

• “Soft” shock recovery – design and implementation

• Effects of shock-loading on material classes

• Effects of Phase Transformation on Shock Behavior

• HE driven versus supported shockwave effects on shock hardening / phase transition kinetics

***Response of materials to Spallation loading***

• Spallation – experimental design

• Shock-induced damage evolution and fracture in different materials

• Influence of shockwave profile on spallation

• HE-driven versus supported Shock (gun-flyer) driven spallation

• Influence of shock prestraining on spallation