

ME 254: Materials Engineering

Chapter 1: Introduction

1st Semester 1435-1436 (Fall 2014)

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Outline

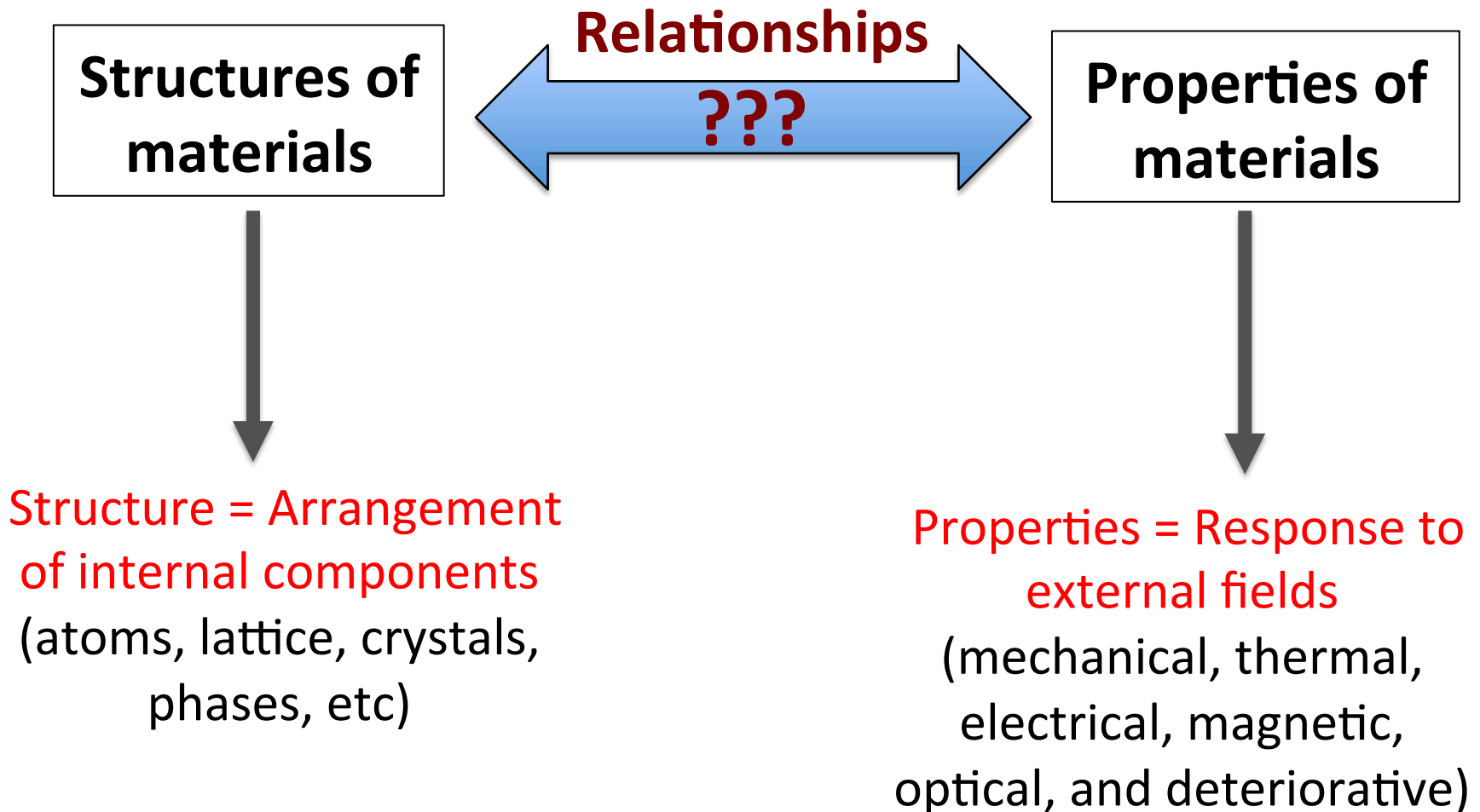
The objective of this lecture is to introduce some of the fundamental terms in MSE.

Topics to be covered:

- ❑ The meaning of Materials Science and Engineering and its objective
- ❑ The definition of material structure and material properties and the relationship between them
- ❑ Classification of materials

HISTORICAL PERSPECTIVE

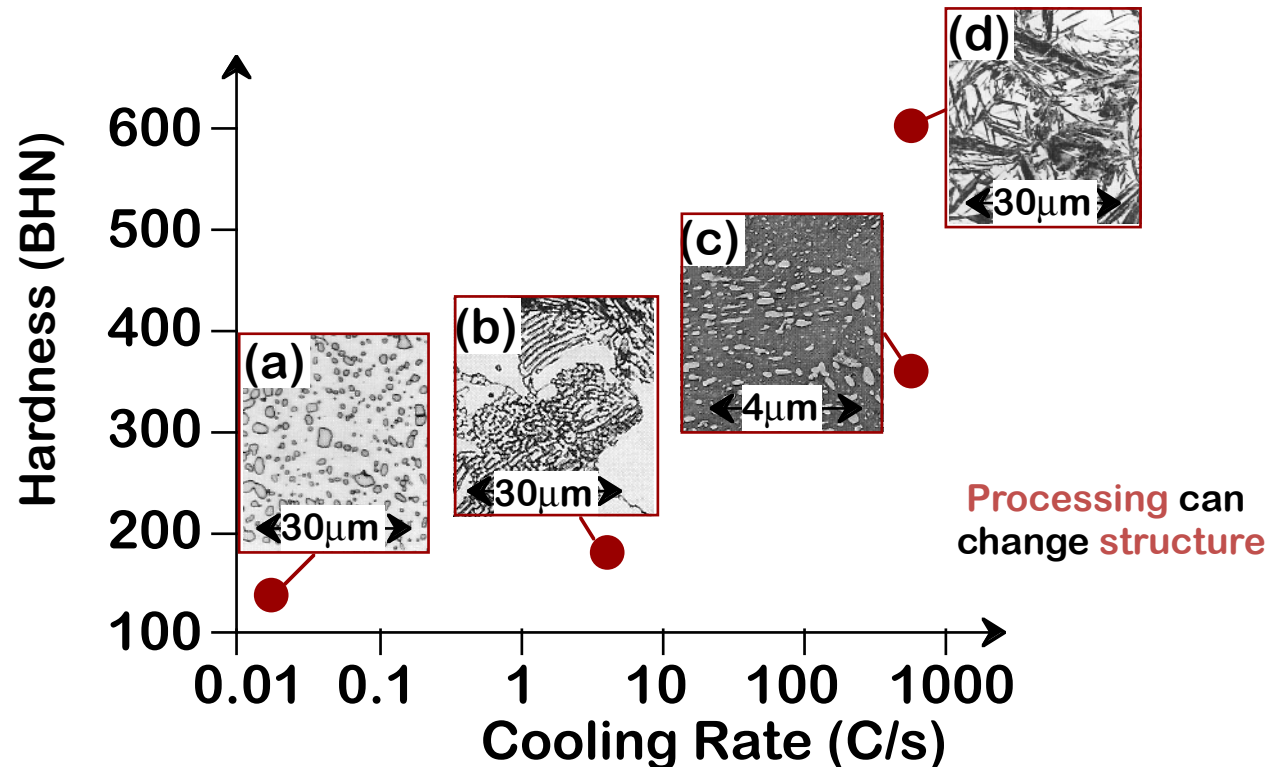
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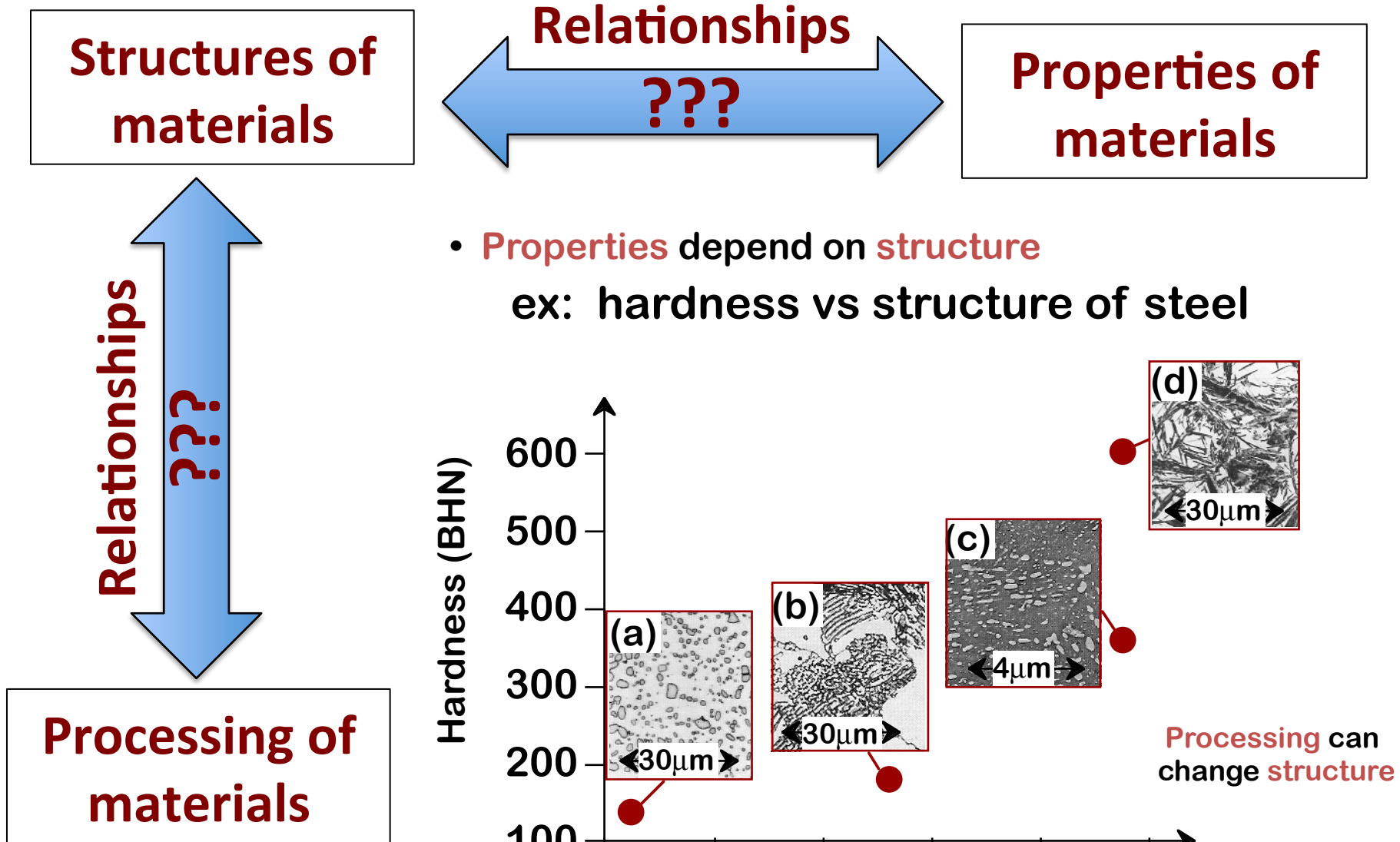
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- **Properties** depend on **structure**
ex: hardness vs structure of steel



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The Materials Selection Process

1. Pick **Application** → Determine required **Properties**

Properties: mechanical, electrical, thermal, magnetic, optical, deteriorative.

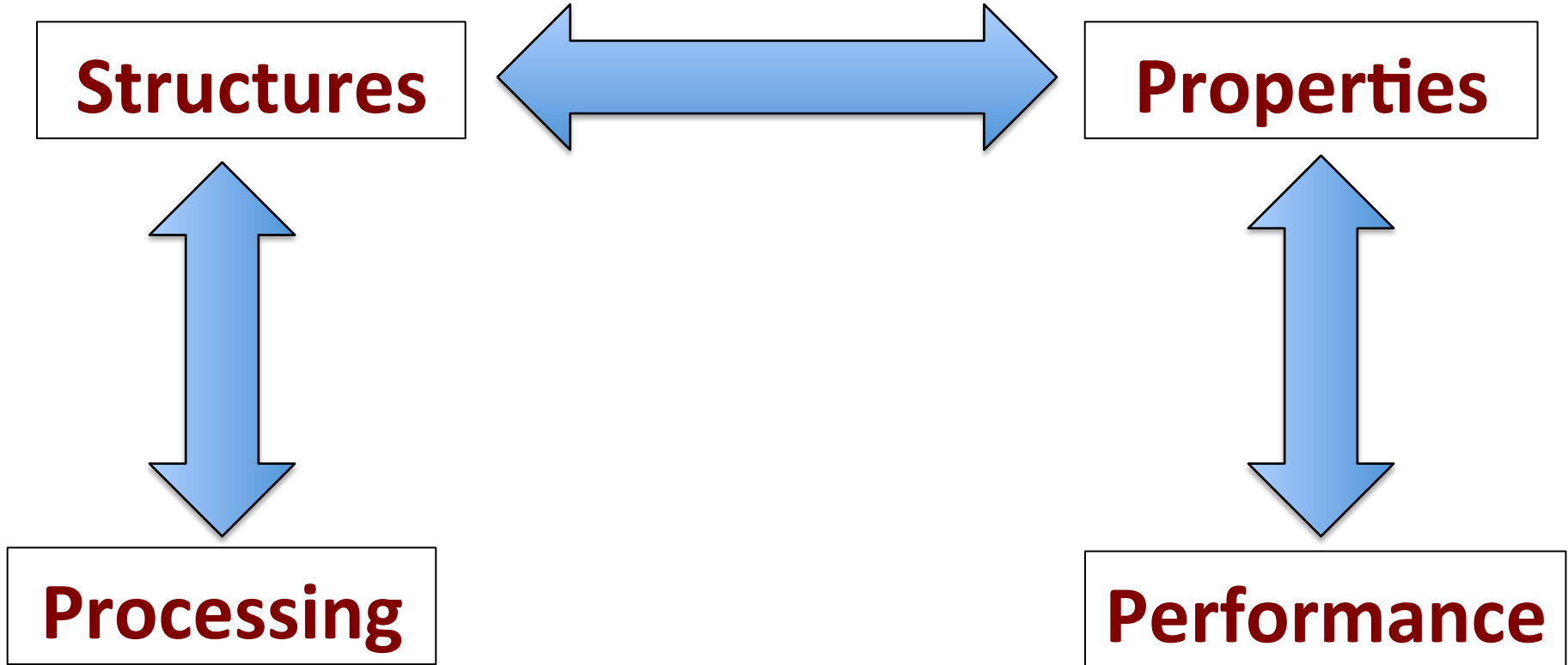
2. **Properties** → Identify candidate **Material(s)**

Material: structure, composition.

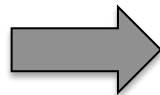
3. **Material** → Identify required **Processing**

Processing: changes *structure* and overall *shape*
ex: casting, sintering, vapor deposition, doping
forming, joining, annealing.

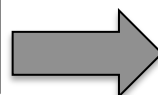
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Processing



Structures

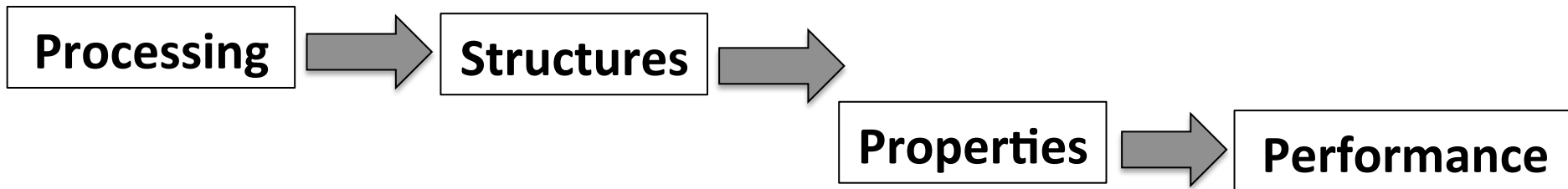


Properties



Performance

Why study materials science and engineering ?



- Selecting right materials for specified applications (*criteria: properties, process conditions, cost, etc*)
- Improving the properties of materials through processing
- What else?!

Classification of Materials

Metals

Ceramic

Polymers

Composites

Advanced materials

Classification of Materials

Metals:

Composed of one or more metallic elements, Fe, Cu, Al (& often small amounts of nonmetallic elements, O₂, N₂, C)

Some typical properties:

Mechanical:

Stiff, strong, ductile, and have high fracture resistance

Electrical and Thermal:

Good conductors to electricity and heat

Optical:

Not transparent to visible light



Classification of Materials

Ceramic

Compounds between metallic and nonmetallic elements (usually oxides, nitrides, carbides). Al_2O_3 , SiC, glass, etc

Some typical properties:

Mechanical:

Stiff, strong, but brittle.
Fracture resistance is low

Electrical and Thermal:

Low electrical conductivities

Optical:

Transparent or opaque



Classification of Materials

Polymers

Plastic and rubbers (mainly based on carbon, hydrogen, and other nonmetallic elements).

Some typical properties:

Mechanical:

Low Stiffness and strength compared to metals and ceramics.

Very ductile.

Electrical:

Low electrical conductivities



Classification of Materials

Composites

Composed of two or more of the above classes (fiberglass, carbonfiber)

The goal is to achieve a combination of properties that is not displayed by any single material.

e.g.

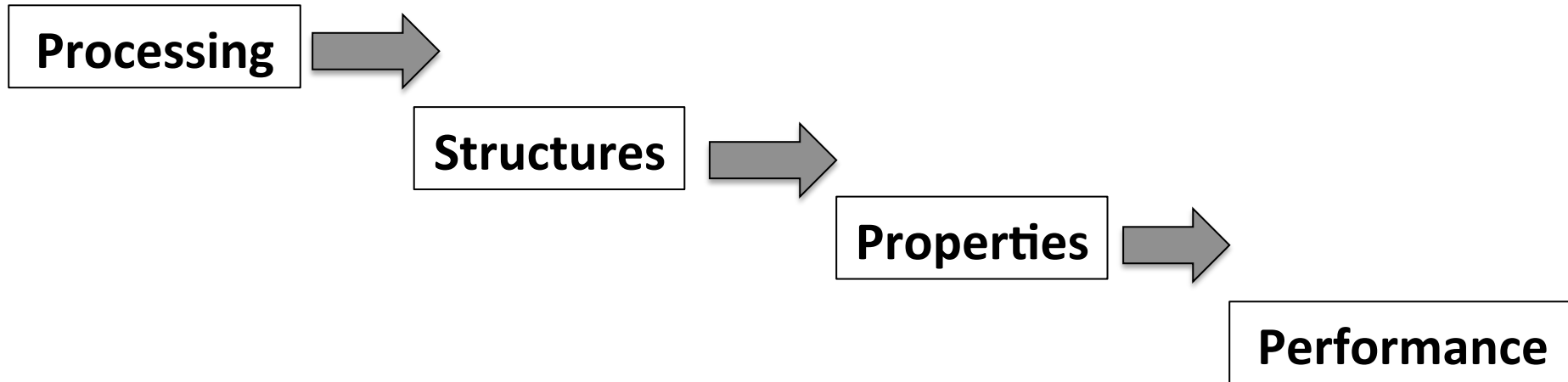
Fiberglass = glass fibers (strong but brittle)+ polymers (ductile but weak)

Advanced materials *(for high-tech applications)*

e.g. semiconductor, biomaterials, nano-materials, etc

Summary

1) Materials Science and Engineering



2) Classification of Materials

(metals, ceramic, polymers, etc)

Read More About Materials Science:

Materials Research Society, www.mrs.org

<http://www.mrs.org/science-enthusiast-learn-something/>

<http://www.strangematterexhibit.com/whatis.html>

Reading assignment for next class:

Chapter 2

2.1 Introduction

2.2 Atomic Structure

~~2.5 Bonding Forces and Energies~~

2.6 Primary Interatomic Bonds

2.7 Secondary Bonding or Van Der Waals Bonding

2.8 Molecules