Materiali Intelligenti: introduzione

Corso Materiali Intelligenti e Biomimetici

1/03/2018

Organizzazione corso Materiali Intelligenti A.A. 2017/18

Parte Teorica

1. Definizione e classificazione
2. Proprietà materiali
3. Polimeri sensibili a ph – T
4. Hydrogel Stiffening
5. Polimeri conduttivi
6. Piezoelettrici
7. Nanomateriali, fullereni
8. Magnetostrittivi & Magneto-reologici
9. Fotosenisibili
10. SMAs
11. Termoresponsivi (termo-elettrici, termo-magnetici)
12. EAPs/DEs
13. Alocromici/Cromogenici

Introduzione al materiale + domande sull'articolo assegnato

Parte Sperimentale

Progettazione guidata dispositivo testing meccanico
(introduzione + lavoro a gruppi + check a fine lezione)

1. Modalità Sensing (cella di carico)
2. Modalità attuazione
3. Controllore (arduino)
4. Meccanismo (ricerca)
5. Design struttura esterna tipo
6. materiale per prototipo/versione definitiva
7. Setup cella carico, motore con arduino
8. progettazione meccanismo
9. progettazione CAD struttura esterna
10. realizzazione struttura esterna (stampa 3D)
11. assemblaggio e testing

- Progetto singolo per l'esame sui diversi materiali intelligenti (formato report)

Esame

- Parte teorica scritta (5 risposte brevi – 1h)
- Parte laboratorio: discussione progetto singolo & di classe

Condivisione articoli e slides:

What's the definition of intelligence?

- Ability to perceive information, retain it as knowledge and then apply it adaptively

- Difference between intelligence and consciousness?

What is an intelligent material?

- Responsive

- Response is reproducible and predictive!

- Reversibility is highly desirable too

- (3Rs- responsive, reproducible, reversibile)

True intelligence: bioinspired

- Sense

- Signals are transferred to brain

- Brain interprets, processes signals

- The information is sent to a responder

- Responder reacts (usually actuation, ie actuates)

Smart material

- a material that has a **useful response to external stimuli**.

- The change is inherent to the material and not a result of some electronics.

- The reaction may exhibit itself as a change in volume, a change in colour or a change in viscosity-or any other material property

- In many cases this reaction is **reversible**

- Example: the coating on spectacles which reacts to the level of UV light, turning your ordinary glasses into sunglasses when you go outside and back again when you return inside. This coating is made from a smart material which is described as being photochromic.

Intelligent Materials

- Actually few materials are intelligent *per se* in the 'true' meaning

- We usually build intelligence using composites, building systems and assembling structures

classification

- properties
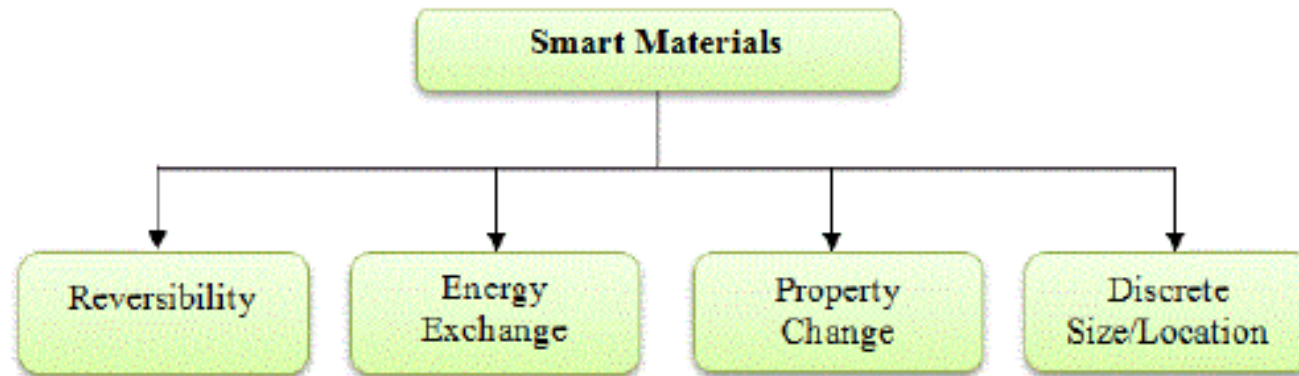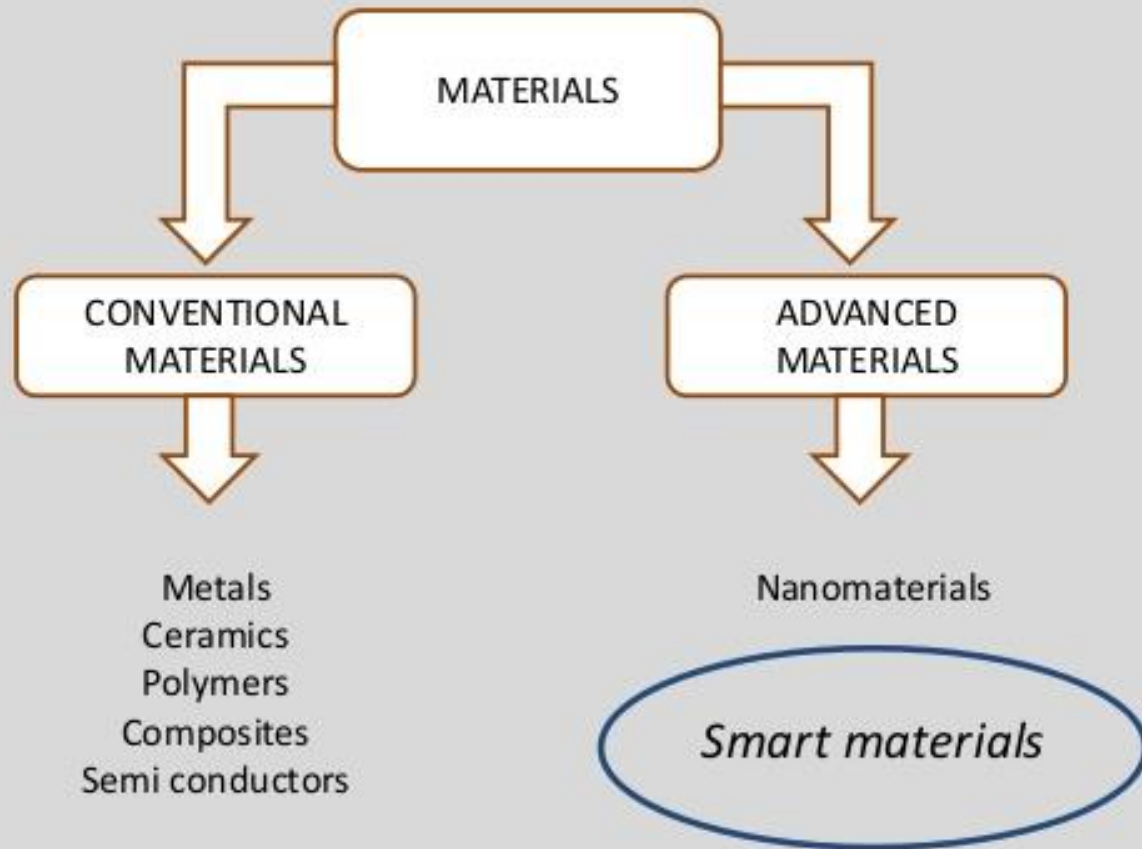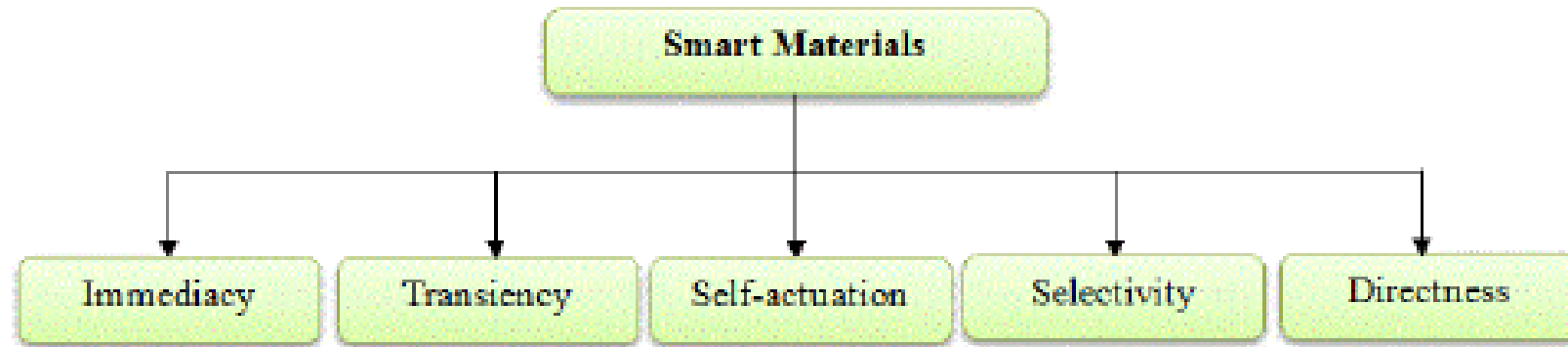
- Active -actuate
- Passive- sense

Figure 1: Smart Materials Classification [2].

CLASSIFICATION OF MATERIALS

MATERIALS

CONVENTIONAL MATERIALS

ADVANCED MATERIALS

Metals
Ceramics
Polymers
Composites
Semi conductors

Nanomaterials

Smart materials

- Programmable materials
- Functional materials
- Advanced materials

Desirable properties

Smart materials vs. Smart structures

distinction between a smart material and a smart structure should be emphasized:

A **smart structure** incorporates some form of actuator and sensor (which may be made from smart materials) with control hardware and software to form a system which reacts to its environment.

A **smart material** reacts to the environments by itself.

Smart system or structure
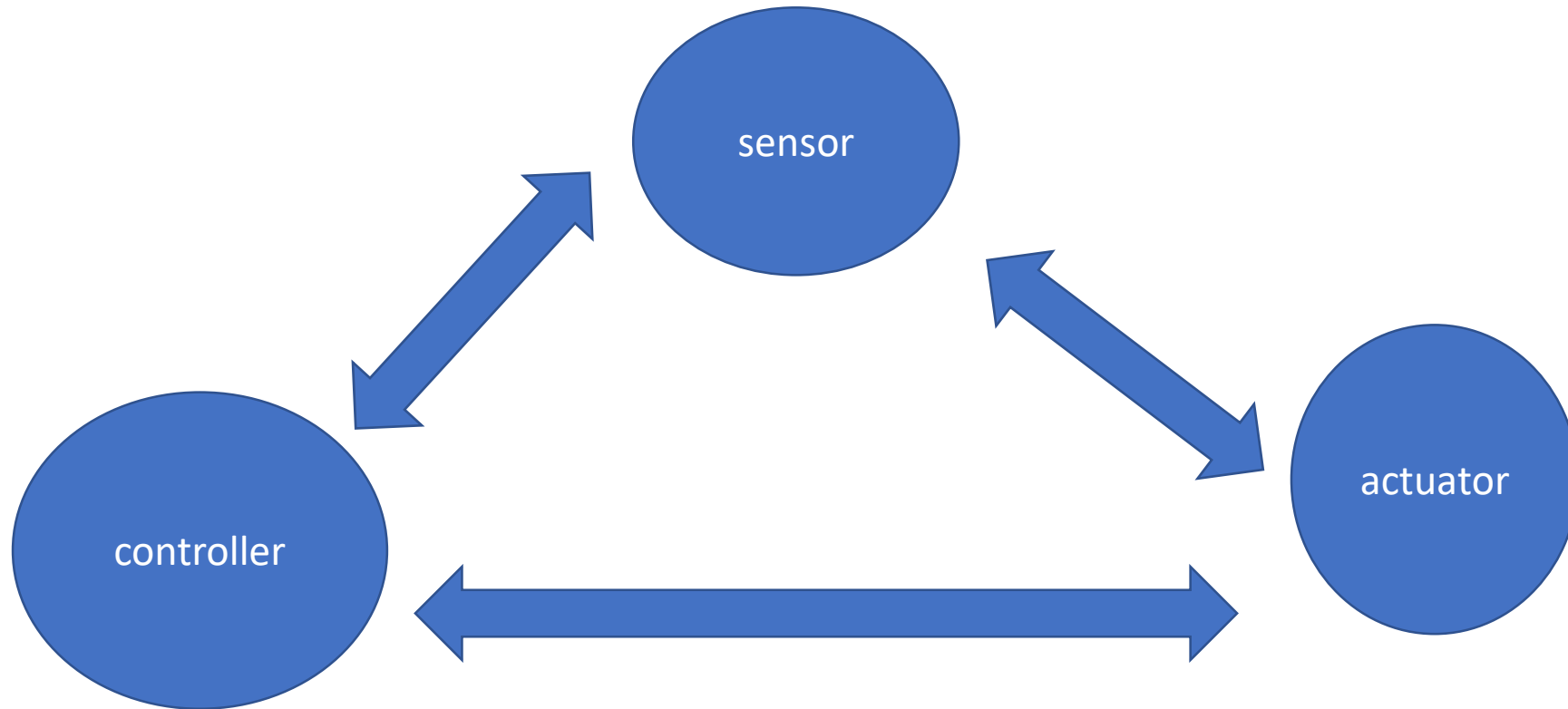
How are they responsive? They respond to

- Light
- Heat
- Electric field
- Magnetic field
- Flow
- pH……

- These stimuli can be external or generated inside the material.

- Other stimuli….?

Vast number of responsive, predictable behaviours

Type	Input		Output
Piezoelectric	Deformation	⬌	Electric field
Pyroelectric	Temperature difference	⬌	Electric field
Thermoelectric	Temperature difference	⬌	Electric field
Electrostrictive	Electric field	⬌	Deformation
Magnetostrictive	Magnetic field	⬌	Deformation

Sensibile a

- Luce
- Temperatura

Risponde con

- Cambia colore
- Cambia forma

Esempio

- Lente fotocromica
- SMA

Perche' MI?

- Human tissues or organs in the body have complicated functions and are not easy to replace with conventional artificial materials.

- Need to design and synthesize materials with better performance

- human beings are dynamic organisms.

- Stimuli-responsive materials with intelligence and drive are also dynamic.

- To achieve more sophisticated drug treatment, or to substitute biological functions, the use of smart materials is inevitable.

Applications?

- Sensing
- Actuation
- Control
- Detection (difference between sensing and detection?)
- Diagnostics
- Damage arrest
- Shock absorbers
- Etc… Many more to invent.