ENGLISH LANGUAGE II

-lectures and exercises-

METALLURGY AND TECHNOLOGY

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week 9

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SMART MATERIALS

Smart materials are able to sense changes in their environments and then respond to these changes or stimuli in a predetermined manner. These traits are also found in living organisms. Smart materials have a sensor that detects an input signal and an actuator that triggers a response and adaptation. Actuators can initiate changes of shape, position or mechanical characteristics in response to changes in temperature, pressure, light, electric fields and/or magnetic fields.

VOCABULARY

- Actuator (noun) - part of a machine or system that moves something or makes something work
- Predetermined (adjective) – established or decided in advance
- Trait (noun) – a distinguishing quality or characteristic, typically one belonging to a person

- Smart Materials are those materials that possess the ability to change their physical properties in a specific manner in response to specific stimulus input
- Stimuli could be pressure, temperature, electric and magnetic fields, chemicals, nuclear radiations etc.
- The associated changeable physical properties could be shape, stiffness, viscosity, damping etc.

Task 2. Work with a partner. Reconstruct the text about materials for actuators from the jumbled sentence parts in the brackets.

Materials Used for Actuators

Shape Memory Alloys

Shape memory alloys … (alloys can consist metal of or polymers)

Shape memory alloys can consist of metal alloys or polymers.

These alloys are thermo-responsive materials, where deformation can be … (caused changes deformation temperature through).

.....

.....

KEY

- Shape Memory Alloys

  ... where deformation can be caused through temperature changes.

After having been deformed, they return to … (changed is original shapes temperature the their when).

.....

.....

Piezoelectric Ceramics

Piezoelectric ceramics expand and contract in response to an applied electric field or voltage; they also generate … (altered an are dimensions electric field their when)

.....

.....

KEY

- ... their original shapes when the temperature is changed.
- Piezoelectronic Ceramics
- ... an electric field when their dimensions are altered.

Magnetostrictive Materials

The behavior of magnetostrictive materials is analogous to that of the piezoelectrics, except that ... (fields magnetic respond they to)

.....

.....

Electrorheological/Magnetorheological Fluids

Electrorheological/magnetorheological fluids are two types of fluids whose properties, e.g. viscosity, can be changed … (an applying by electric field magnetic or)

.....

.....

(from Callister, modified and abridged)

KEY

- Magnetostrictive Materials
- ....they respond to mahnetic fields.

- Electrorheological/Magnetorheological Fluids
- ... by applying an electric or magnetic field.

7.6 Nanotechnology

The history of science shows that, to understand the chemistry and physics of materials, researchers generally have begun by studying large and complex structures and then later investigated smaller fundamental building blocks of these structures.

However, *scanning probe microscopes*, which permit observation of individual atoms and molecules, make it possible to manipulate and move atoms and molecules to form new structures and thus design new materials that are built from simple atomic-level constituents, an approach called 'materials by design'. This ability to arrange atoms provides opportunities not otherwise possible to develop and study mechanical, electrical, magnetic and other properties. In the term nanotechnology, the prefix nano denotes that the dimensions of these structural entities are on the order of a nanometer (10^{-9} m). As a rule, they are less than 100 nanometers (equivalent to approximately 500 atom diameters).

(from Callister, modified and abridged)

Glossary

scanning probe microscope	(SPM), a microscope that scans across the specimen surface line by line, from which a topographical map of the specimen surface (on a nanometer scale) is produced

Task 1. *The text refers to two kinds of scientific approaches, the top-down and the bottom-up approach. Explain.*

In the so-called top-down approach to the chemistry and physics of materials, researchers study .....

.....

.....

In the so-called bottom-up approach, ...

.....

.....

.....

KEY

7.6 Nanotechnology

Task 1. Suggested Solution

In the so-called top-down approach to the chemistry and physics of materials, researchers study large and complex structures first and then investigate smaller fundamental building blocks of these structures.

In the so-called bottom-up approach, researchers arrange atoms in order to develop and study mechanical, magnetic and other properties which would otherwise not be possible.

7.7 Case Study: Carbon Nanotubes

Task 1. Work with a partner. Fill the gaps in the text with words from the box in their correct form.

applicable; atom; consist; diameter; ductile; efficient; end; field; know; molecule; thickness

The structure of a nanotube ..... of a single sheet of graphite, one atom in ....., which is rolled into a tube. At least one ..... of the tube is capped with a C_{60} *fullerene* hemisphere. Each nanotube is a single ..... composed of millions of ..... The length of the molecule is thousands of times greater than its ..... Nanotubes are extremely strong and stiff and relatively ..... For single-walled nanotubes, tensile strengths range between 50 and 200 GPa, which is the strongest ..... material so far. Nanotubes have unique electrical properties and are ..... conductors of heat. Because of their unique properties, nanotubes are extremely useful as reinforcement in composite materials and will be ..... in many ways in nanotechnology, electronics, optics and other ..... of materials science.

(from Callister, modified and abridged)

KEY

7.7 Case Study: Carbon Nanotubes

Task 1.

consists; thickness; end; molecule; atoms; diameter; ductile; known; efficient; applicable; fields

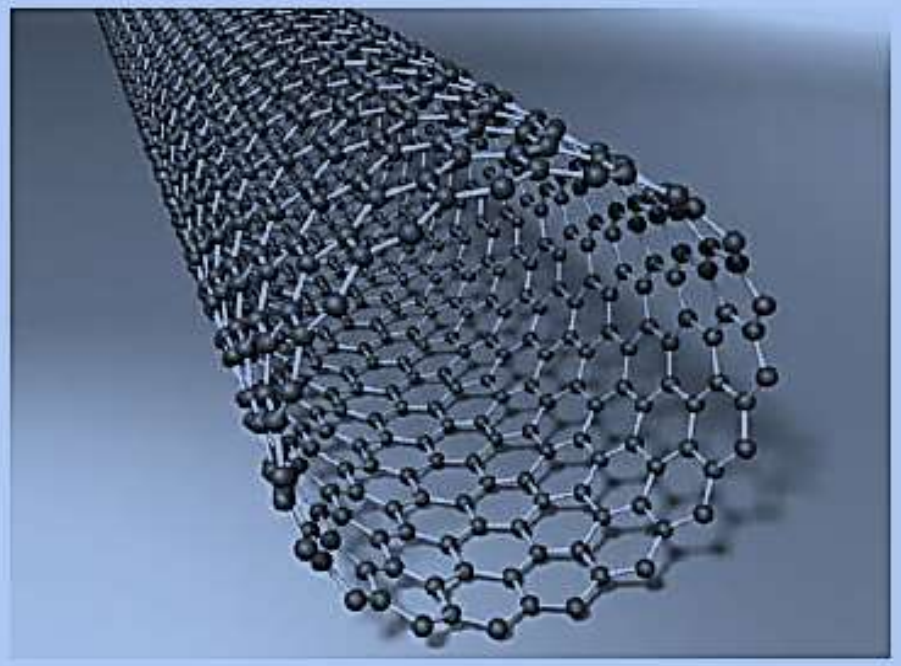

Figure 18: Carbon nanotube structure

Glossary

fullerene	carbon molecule named after R. Buckminster Fuller, sometimes called buckyball, composed entirely of C in the form of a hollow sphere, ellipsoid or tube

7.8 Grammar: Modal Auxiliaries

Scientific texts use constructions with modal auxiliaries, also called 'modals', e.g. when the texts are about a potential future development or when hypothetical statements are made.

Formation and Use of Modal Auxiliaries

Modals require the verb in the infinitive.

Solar energy **could** significantly **reduce** consumption of oil in coming decades.

Modals do not add do/does/did in questions or in negative sentences.

Fuel cells **may not** provide enough energy to sufficiently reduce fuel consumption.

Modals have no past or future form (except for could and would).

Modals and their Meanings

can and **could** express

the ability and the permission to do sth, cf. to be able to and to be allowed to;

a request, offer, suggestion, possibility, where **could** is more polite

may expresses the possibility and permission to do sth; a polite suggestion

might expresses a possibility (less possible than **may**) and a *hesitant* offer

must expresses a force, necessity, an *assumption*, an advice, a recommendation;

but **must not** expresses *prohibition* (!)

need not expresses that there is no necessity to do sth

shall expresses a suggestion

ought to and **should** express an advice, an obligation

will expresses a wish/request/demand/order (less polite than would); a prediction/assumption, promise, spontaneous decision, *habits*

would expresses a wish/request (more polite than will), habits in the past

Glossary

hesitant	unable to make a decision quickly
assumption	here a belief that sth is true
prohibition	a law or order that forbids sth
habit	a usual behavior

Task 1. Fill the gaps with modals. Several modals may apply, depending on the intention you want to express. Remember to use the passive voice when necessary.

The term smart ..... (apply) to rather sophisticated systems.

Viscosity ..... (change) when applying an electric or magnetic field.

Materials ..... (make) that bend, expand or contract when a voltage is applied.

Recyclable materials ..... further ..... (develop).

Materials for more efficient fuel cells ..... still ..... (find).

Nanotubes ..... (be) applicable in many ways.

The ecological impact of manufacturing materials ..... (consider).

KEY

7.8 Grammar: Modal Auxiliaries

Task 1. Suggested Solution

can be applied; will change; could be made; ought to be further developed; might still be found; can be ; must be considered

THANK YOU FOR YOUR ATTENTION