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SUSTAINABLE DEVELOPMENT IN MATERIALS ENGINEERING

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Abstract: *Materials engineering and sustainable development are closely linked. Many aspects of sustainable development depend on appropriate and timely actions of materials engineers. Materials engineering is an extended process where trough the processing, structure, properties and performance engineers developed sustainable solutions. Materials engineering embraces many disciplines and sustainable solutions are usually inter-disciplinary. Sustainable solutions have not only an environmental dimension, but also economic and social dimensions.*

The challenge of engineers towards sustainability is to promote zero manufacturing waste, develop molecules that are not persistent, toxic and bio accummulative as well as to have no hazardous manufacturing processes. These goals typically result in common practices among engineers to design new processes and products and to upgrade the existing ones satisfying the three aspects of sustainability i.e. economic development, environmental protection and societal goods.

Key words: *materials engineering, sustainable development, environment*

INTRODUCTION:

Today materials enable society to develop and prosper and materials are indispensable in our current wealth and wellbeing. Materials support our current society in regards to provision sustainable solutions in the field of energy, water, transport, shelter and information and communication technologies. Moreover, materials present an integral part of every aspect of daily life, but some materials developments have undesirable impacts on the environment and human health.

Applying materials engineering there are two overarching sustainable materials objectives: detoxification and dematerialization. Detoxification describes the reduction of the toxic characteristics of materials used in products and processes. Dematerialization involves recycling and reusing of materials, redesign products or substitute non-material service for material-intensive products (Geiser 2001).

SUSTAINABILITY

Sustainability is an imperative for economic development and there are many approaches for its defining. The World Commission on Environment and Development (WCED 1987) defined the sustainable development as:

"*development that meets the needs of the present without compromising the ability of the future generations to meet their own needs*"

The definition for sustainability found in Western Australian Government (GoWa 2003) integrates environmental, social and economic aspects as:

"*sustainability means meeting the needs of current and future generations trough an integration of environmental protection, social advancement and economic prosperity*"

Social and environmental performances are daily improving, but still the role of industry in sustainable society is not clear. Sustainability can drive innovations in materials and materials engineering in regard to eco-efficiency, green chemistry, green engineering and industrial economy.

MATERIALS ENGINEERING

Investigating the relationships that exist between structures and properties of materials is involved in discipline materials science. In contrast, based on the structure – properties correlations, designing or engineering the structure of materials to produced predetermined set of properties is involved in discipline materials engineering.

The arrangement of the initial component usually relate to the structure of material. Subatomic structure involves electrons within the individual atoms and interaction with their nuclei. On the atomic level, structure encompasses the organization of atoms and molecules relative to one other.

Property is a material trait in terms of the kind and magnitude of response to as specific imposed stimulus. Six different categories of properties are important for solid materials: mechanical, electrical, thermal, magnetic, optical and deteriorative. For each there is a characteristic type of stimulus capable of provoking different response. The deformation to an applied load or force relate to the mechanical properties (elastic modulus and strength). Electric field is the stimulus for electric properties (electrical conductivity and dielectric constant). Heat capacity and thermal conductivity can be represented as thermal behavior of solids. The response of material to the application of a magnetic field demonstrates magnetic properties. Electromagnetic or light radiation is the stimulus for optical properties (index of refraction and reflectivity). The chemical reactivity of materials indicates deteriorative characteristics.

Two other important components in addition to structure and properties are involved in the science and engineering of materials: processing and performance. So, the structure of materials will depend on how it is processed and furthermore the performance of material will be function of its properties. The interrelation between processing, structure, properties and performance is linear (Fig. 1) and presents the base in terms of design, production and utilization of materials.

Processing → Structure → Properties → Performance

Fig.1. Linear interrelationship of the four components of the discipline of materials science and engineering

The basic classification of solid materials is in three groups: metals, ceramics and polymers. The classification is based primary on atomic structure and chemical make-up, and most materials belong to one distinct grouping or another, although there are some intermediates. In the other group of three important engineering materials are: composites, semiconductors and biomaterials.

Metals have large number of non localized electrons which are not bound to particular atoms and many properties of metals are directly attributed to the existence of these electrons. So, metals are extensively used in structural applications because they are quite strong, yet deformable. Metals are extremely good conductors of electricity and heat.

Ceramics are compounds between metallic and nonmetallic elements, mostly oxides, nitrides and carbides. Ceramics classification includes materials composed of clay minerals, glass and cement. Ceramics is more resistant to high temperatures and harsh environments than metals and polymers. Ceramics are hurt, but very brittle as well as typically insulative to the passage of electricity and heat.

Polymers include plastic and rubber materials. These materials are extremely flexible, low densities and large molecule structure. They present organic compounds based on carbon, hydrogen and other nonmetallic elements.

Many of the recent development in materials are attributed to the composite materials. Composites consisted of two or more materials that apart have quite different properties (do not dissolve or blend into each other), but together, gave to the composite unique properties. The first and up to now the most common composite materials is fiberglass in which glass fibers are embedded within the polymer material.

The electrical properties of semiconductors are intermediate between the electrical conductors and insulators. These materials have extremely sensitive electrical characteristics which influenced to the recent development of electronic and computer industries.

Biomaterials are used as implants in the human body for replacement of diseased or damaged body part. The materials must be compatible with body tissues and not to be toxic. The above mentioned materials: polymers, ceramics, metals, composites and semiconductors may be used as biomaterials.

In spite of the whole progress which has been made in the past years in the field of materials engineering there still remain technological challenges in development sophisticated and specialized materials satisfying the social, environmental and economic aspect of society (Ashby.M.F., 1996; Callister W.D. 2001).

CONCLUSION

Materials engineering take the challenge to find solutions for many aspects related to sustainable future. Many examples have been drawn from research work in the field of materials engineering towards the important issue of sustainability. For instance, materials engineers play the important role in creation the new methods for hydrogen storage. There are number of findings related to the new types of high-efficiency batteries and environmentally friendly corrosion inhibitors as well as lightweight alloys for energy conservation. Nanotechnology is of key importance for fabrication cheap and simpler solar cells and biomimetic materials. Also, there are increasing numbers of solutions that are being created in areas connected with the environment and sustainable engineering, ranging from recycling, to water instrumentalities and pollution reduction.

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