

# SMART MATERIALS-TYPES SS AND THEIR APPLICATION: A REVIEW

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**Abstract** - In the manufacturing world now we need some 'Intelligent' or Smart materials which can change their property according to our requirement. Smart materials are one of the unique material and the general characteristics of all these materials are common that is their behaviour or significant property can be altered, reversed or controlled under the influence of external impetus. Their smartness can be characterized by its self-adaptability, self-sensing and self-healing in response to any external stimuli. In simple words 'Smart Materials' may be defined as the material which react to its environment on its own ,the reaction may exhibit itself as a change in volume, color, viscosity, odour and this may occur in response to a change in temperature, stress, electric current, pH or magnetic field. Smart materials have a stupendous effect on variety of fields since its discovery to its present day and also its impact is visible in our day to day life through its application in smart infrastructure to smart sensors as well as smart gadgets and vehicles. In this paper we have focused on the introduction to smart materials, their current and potential application in different fields, brief discussion about their type such as actuators, shape memory alloy, piezoelectric material and so on.

**Keywords:** Smart materials, Actuators, sensors, smart system.

## I. INTRODUCTION

In the production world, the high technologies push towards the 'Smart' system in which we need some intelligent or smart material which can alter their properties according to our requirement. A smart material can be defined as the material which can change their behavior or their properties as per change in the atmosphere or in the response of external stimuli and these stimuli could be anything i.e. pressure, force, temperature, stress. After the Ceramic and Composite materials the era of smart material has come. As present scenario the developments, technologies, changes in production accompanied by new era materials which offers unique mechanical and physical properties. Among these materials, the composites do not cease evolving towards new products which are, either the least expensive possible, or the most powerful, or both at the same time [1]. This concept of "Smart materials" or intelligent materials are used to characterize the material those are able to answer in the suitable way to the surrounding and changes in it. Different types of Smart materials have been used in the new area of technologies [2,3]. These materials have the qualities to fit in the surrounding and in order to response the physical changes, they can modify their form, their dimensions or even their mechanical properties (Young modulus). In fact, a material able to answer to its environment presents a very interesting profile for industrial applications; and actually the materials the most frequently used because of their intrinsic remarkable properties, are the piezoelectric materials and memory shape alloys [4-6].

## II. TYPES OF SMART MATERIALS

Smart materials are that materials who have one or more properties that can be significantly altered in a

control manner by external impetus, such as stress, temperature, moisture, pH, electric and magnetic field. Smartness can be describe by self-adaptability, self-sensing and self-repairing. These smart materials offers numerous of application in every field. According to their different properties different types of smart materials are available and some of them are discussed below:

### 2.1 Shape memory Alloy

Shape memory alloy is very common example of Smart material. Basically these type of smart material has tendency to retain its original when subjected to external stimuli i.e. stress. These shape changes occurs between two phase martensite to austenite. Martensite phase is stable at lower temperature and austenite phase is stable at higher temperature. Basically these material exist between two phase. Because of these excellent mechanical properties the application of these materials has been increasing day by day such as in the field of automotive, aerospace, mini actuators and micro electromechanical systems (MEMS) and biomedical.

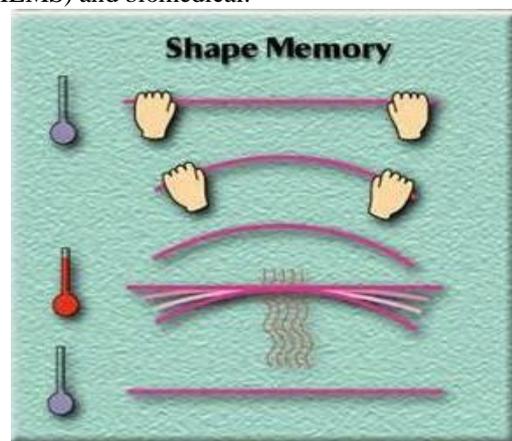


Fig 1 Shape memory alloy

## 2.2 Piezoelectric materials

These are also the one of the most common type of smart materials. Piezoelectric materials has tendency to produce voltage when stress is applied and same process can happens in a reversible manner. The structure made with this material can bend, expand and compress.

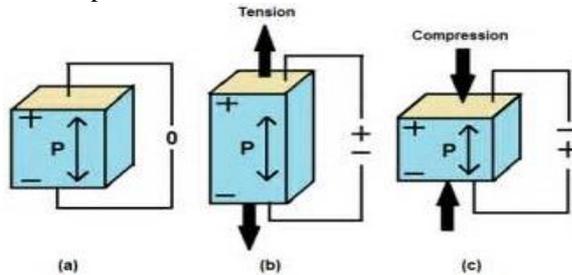


Fig 2 Piezoelectric material

## 2.3 Thermo-responsive Materials

In this kind of smart materials, these materials have ability to hold different shapes at different temperature.

## 2.4 Magneto-restrictive Materials

These materials are that kind of Smart materials that can alter their shape when subjected to magnetic field. This is reversible process so when magnetic field will be applied then change in shape will occur. These materials are almost similar to the piezoelectric materials difference is only that they respond to electric field while magneto-restrictive material has tendency to response to the magnetic field.

## 2.5 Chromic Materials

These materials have very excellent property to change their color when subjected to external impetus (temperature, lights, electric field). These materials can more classified into (i) Thermo chromic materials (ii) Photo chromic materials (iii) Halo chromic materials.

## 2.6 pH sensitive materials

This kind of smart materials have properties to change their color when their will be the change in the acidity of the liquid. These kind of smart materials can be use to indicates the corrosion by mixing it with the paint.

## 2.7 Magneto-rheostatic fluid

This is also a type of smart material in which a fluid who has viscosity almost to the oil will solidifies when brings into the magnetic field. The solidification of the liquid is that much strong that it can lift 100kgs without any problem.

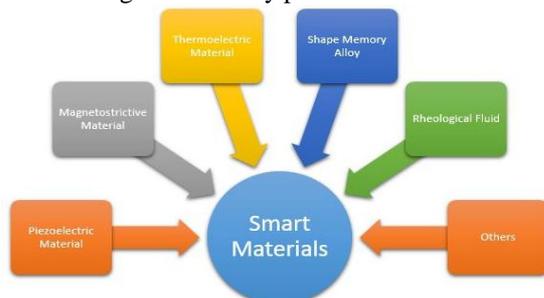


Fig 3 Types of smart materials

## III. APPLICATIONS

In past few decades, the new technologies is taking great intrest in the Smart materials to make it more applicable in commercial, production and many other field. Due to the great potential and excellent mechanical and physical properties, these materials has drawn the attention of many scientists and researchers and that's why they are trying to make these materials more familiar in every field. The property of self-healing, self-adaptability is increasing its chances more than the composites and the ceramics. The smart structure made up with one or more smart materials, actuators and sensors has create the great interest in this field. Some major field of application of smart materials are:

### 3.1 Aeronautics

The Smart material plays a great role in the field of aeronautics. In aircraft or automotive structure to reduce the vibrations we use Piezoelectric actuators. Later in aircrafts we used shape memory alloy to control the spatial goal i.e the structure of aircrafts during the deformations, checking the upper and lower surface of the wings to increase the lift or decrease the drag, to reduce shock waves, to reduce the breaking stresses of the blades to reduce vibration and noise.

### 3.2 Structural Health Monitoring

The embedding smart sensors within the structure to monitor the damage and stress and can reduce the repairing cost and can increase their life. This smart health monitoring of structure is using over forty bridges worldwide.

### 3.3 In Nuclear industries

Smart materials and smart structure offers great range of application to the nuclear filed from enhancing safety measures to the personal exposure reduction, life-cycle cost reduction and performance improvement. The most challenging one is to reduce the radiation environment but it needs very skilled who has knowledge about which material is enough strong to response to the radiation environment.

### 3.4 In the Civil Engineering

Smart materials plays very important role in the field of engineering. It is able to detect the cracks in concrete structure, vibration of tall buildings, to predict the choc waves in the concrete and metallic structure. Can analyze innovative seismic retrofit of buildings and bridges.

### 3.5 In Medical field

In the field of medical science and biomedical lots of research I still going on for the better results. Now a days, for artificial muscle application, poly-electrolyte gels are being experimented, in whicha polymer matrix swollen with a solvent that can expand or contract when exposed to an electric field. Moreover the robot doctors for the surgery is not the new for this field. For example neurosurgical robot MINERVA (To carry out operational acts).

### 3.6 Reducing Waste

In a present scenario electronic and non-disposable waste is increasing day by day in all over the world. The radiation from this is also hazardous for human being should be remove first. In this situation smart materials can help to automate this process. Manufacturing of fasteners constructed from shape memory materials are used that can self-release on heating. Once these fasteners will be form then the hazardous and recyclable waste can easily separable. Using these fasteners different temperatures, products could be disassembled hierarchically so that materials can be sorted automatically.

### CONCLUSION

With the developments of our technologies, we need to change our traditional material with the material who have smartness and intelligence. Those materials who can response to the external changes and according to that changes can alter their physical and mechanical properties. There are numerous type of smart materials but still lots of research and work is going to be done in the field of these materials to make it familiar in all the field. The smart structure is playing excellent role in each filed of science. At present there are numerous filed where smart materials are doing great job i.e. in the field of aeronautics, automotive industries, structural health monitoring , civil engineering, in the field of medical

science). Smart materials has vast potential application in every filed.

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