A

Seminar report

On

SMART MATERIAL

Submitted in partial fulfillment of the requirement for the award of degree
Of Civil

SUBMITTED TO: **SUBMITTED BY:**

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Preface

I have made this report file on the topic **Smart Material;** I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to …………..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Acknowledgement

I would like to thank respected Mr…….. and Mr. ……..for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

Secondly, I would like to thank my parents who patiently helped me as i went through my work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs.

Thirdly, I would like to thank my friends who helped me to make my work more organized and well-stacked till the end.

Next, I would thank Microsoft for developing such a wonderful tool like MS Word. It helped my work a lot to remain error-free.

Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

CONTENT

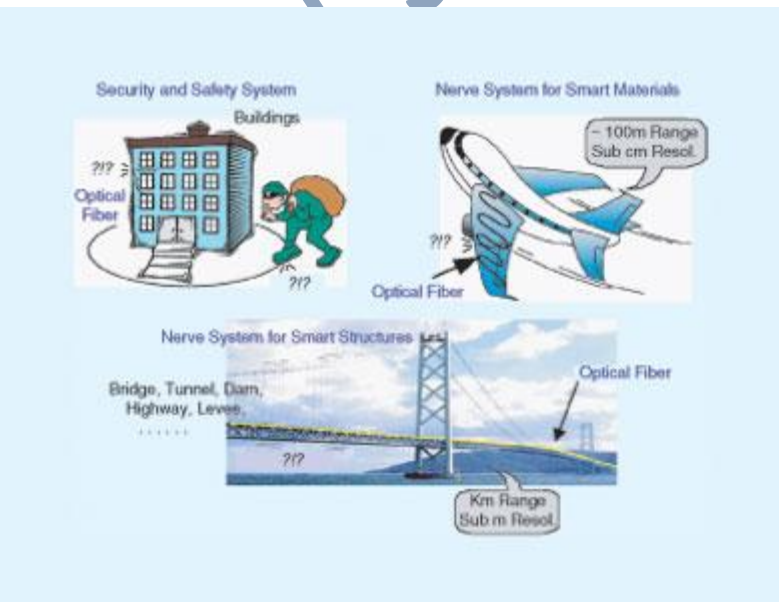
INTRODUCTION

INTRODUCTION

There is an increasing awareness of the benefits to be derived from the development and exploitation of smart materials and structures in applications ranging from hydrospace to aerospace. With the ability to respond autonomously to changes in their environment, smart systems can offer a simplified approach to the control of various material and system characteristics such as light transmission, viscosity, strain, noise and vibration etc. depending on the smart materials used [1]. There are a number of materials that act as both sensors and actuators that can monitor and respond to their environment. However, with the ability to also modify their properties in response to an environmental change, they can be 'very smart' and, in effect, learn. While the scope of sensors and actuators is quite broad, three main sub-programs have been identified – Smart Structures and Materials, Miniature Sensor and Actuators and Automated Testing, Inspection Monitoring and Evaluation. These are exciting times for Sensors and Actuators with the maturing of the enabling technologies of Photonics and Electronics paving the way for inventive and innovative system designs. For the modelling of sensor behaviours, the ultimate objective is to build intelligent autonomous virtual humans with adaptation, perception and memory. These virtual humans should be able to act freely and emotionally. They should be conscious and unpredictable. The virtual humans are expected in the near future to represent computer the concepts of behaviour, intelligence, autonomy, adaptation, perception, memory, freedom, emotion, consciousness, and unpredictability. Behaviour for virtual humans may be defined as a manner of conducting themselves. It is also the response of an individual, group, or species to its environment.

BACKGROUND

Smart Materials are materials that respond to environmental stimuli, such as temperature, moisture, pH, or electric and magnetic fields. For example, photochromic materials that change colour in response to light; shape memory alloys and polymers which change/recover their shape in response to heat and electro- and magnetorheological fluids that change viscosity in response to electric or magnetic stimuli. Smart Materials can be used directly to make smart systems or structures or embedded in structures whose inherent properties can be changed to meet high value-added performance needs. Smart Materials technology is relatively new to the economy and has a strong innovative content. According to work by the Materials Foresight Panel, the use of smart materials could make a significant impact in many market sectors. In the food industry, smart labels and tags could be used in the implementation of traceability protocols to improve food quality and safety e.g. using thermo chromic ink to monitor temperature history. In construction, smart materials and systems could be used in 'smart' buildings, for environmental control, security and structural health monitoring e.g. strain measurement in bridges using embedded fibre optic sensors



that can feel pain with fiber optic nerve systems.

Magneto-rheological fluids have been used to damp cable-stayed bridges and reduce the effects of earthquakes. In aerospace, smart materials could find applications in 'smart wings', health and usage monitoring systems (HUMS), and active vibration control in helicopter blades. In marine and rail transport, possibilities include strain monitoring using embedded fibre optic sensors. Smart textiles are also finding applications in sportswear that could be developed for everyday wear and for health and safety purposes [8]-[12].

A. Structural Health Monitoring

Virtual human robots can be equipped with sensors, memory, perception, and behavioral motor. This eventually makes these virtual human robots to act or react to events.

* Also called Damage Detection

* Using response signals to determine if there has been a change in the system's parameters.

* Mathematically very much like parameter identification in many respects

* Numerous methods have been proposed.

* Impact is high for SMH systems that work without taking the base system out of operation.

B. Smart Structures

Key areas of focus for the development of smart structures to include: Miniaturisation and integration of components, e.g. application of sensors or smart materials in components Robustness of the smart system, e.g.interfacial issues relating to external connections to smart structures Device fabrication and manufacturability, e.g. Electrorheological fluids in active suspension systems, applications in telematics and traffic management Structural health monitoring, control and lifetime extension (including self-repair) of structures operating in hostile environments, e.g. vibration control in Aerospace and Construction applications. Thermal management of high temperature turbines for power generation. Selfmonitoring, self-repairing, low maintenance structures, e.g. bridges and rail track Smart structures that can self-monitor internal stresses, strains, creep, corrosion and wear would deliver significant benefits.

Projects can be based on any material format (e.g. speciality polymers, fibres and textiles, coatings, adhesives, composites, metals, and inorganic materials), which incorporate sensors or active functional materials such as: piezoelectrics, photochromics, thermochromics, electro and magneto rheological fluids, shape memory alloys, aeroelastictailored and other auxetic materials. For the modelling of actor behaviors, the ultimate objective is to build intelligent autonomous virtual humans with

adaptation, perception and memory. These virtual humans should be able to act freely and emotionally. They should be conscious and unpredictable. But can we expect in the near future to represent in the computer the concepts of behavior, intelligence, autonomy, adaptation, perception, memory, freedom, emotion, consciousness, and unpredictability [9]-[10].

C. Key Points

* This is the first successful trial in the worldto remotely control a man emulating robot soas to drive an industrial vehicle (backhoe) outdoors in lieu of a human operator.

* Furthermore, the robot's operation was controlled while having it wear protective clothing to protect it against the rain and dust outside. This too marks a world-first success demonstrating the robot's capability of performing outdoor work even in the rain.

* This has been achieved with an HRP- IS robot whose Honda R&D made hardware was provided with control software developed by the AIST.

* The robot has a promising application potential for restoration work in environments struck by catastrophes and in civil engineering and construction project sites where it can "work" safely and smoothly.

D. Outline

This robot was remotely controlled to perform outdoor work (Fig.5) tasks normally carried out by human operators involving the operation (driving and excavation) of a vibrating industrial vehicle (backhoe) in the seated position. Furthermore, operation was

achieved with the robot wearing protective clothing to protect against rain and dust. This also marks a world first success indicating the robot's ability to carry out outdoor work tasks even in the rain. These results were achieved thanks to the development of the following three technologies:

* The "remote control technology" for instructing the humanoid robot to perform total body movements under remote control and the "remote control system" for executing the remote control tasks (KHI).

* The "protection technology" for protecting the humanoid robot against shock and vibrations of its operating seat and against the influences of the natural environment such as rain and dust (Tokyo Construction).

* The "full-body operation control technology" for controlling the humanoid robot's total body work movements with autonomous control capability to prevent the robot from falling. There have been many attempts until the present to robotize the industrial vehicles (including backhoes) themselves for work on sites requiring their operation

in dangerous work areas or in adverse environments. In contrast, the use of a humanoid robot to operate the industrial vehicle instead of a human operator has two distinct advantages:

* This means that robot does not only drive the vehicle but is also capable of executing the attendant work tasks (alighting from the vehicle to check the work site, carrying out simple repairs, etc.) and

* It permits the robotizing of all industrial vehicles without needing to modify them. Once humanoid robots (Fig. 5) now engaged in other types of work can be used, when necessary, for operational duties normally performed by human operators there will be a definite chance for a greater expansion of the humanoid robot market which in

turn holds promise of further reductions in their production and operating costs. The major insight gained from this success that has demonstrated the humanoid robot's ability to replace the human operator in operating (driving and excavation duties) commercially used industrial vehicles (backhoe) under remote control is the realization that humanoid robots are capable of moving in the same manner as humans. The humanoid robot's ability to carry out outdoor work tasks even in the rain by "wearing" protective clothing has widened the scope of the environmental conditions in which it is capable of executing work. From these two aspects there is every reason to expect that these results will make a substantial contribution toward the realization of practical work-performing humanoid robots. The development tasks ahead will include work to create wireless remote control and achieve a robot capable of boarding the industrial vehicle independently

TYPES OF SMART MATERIAL

1 PIEZOELECTRIC CERAMICS

2 VISCOELASTIC

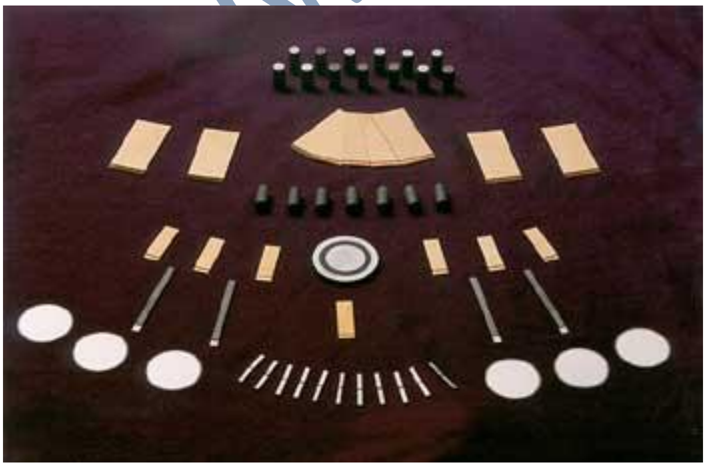
3 ELECTRORHEOLOGICAL FLUID

4 SHAPE MEMORY ALLOY

5 OPTICAL FIBRE

6 SMART GEL PH- SENSTIVE POLIMERRS

PIEZOELECTRIC CERAMICS

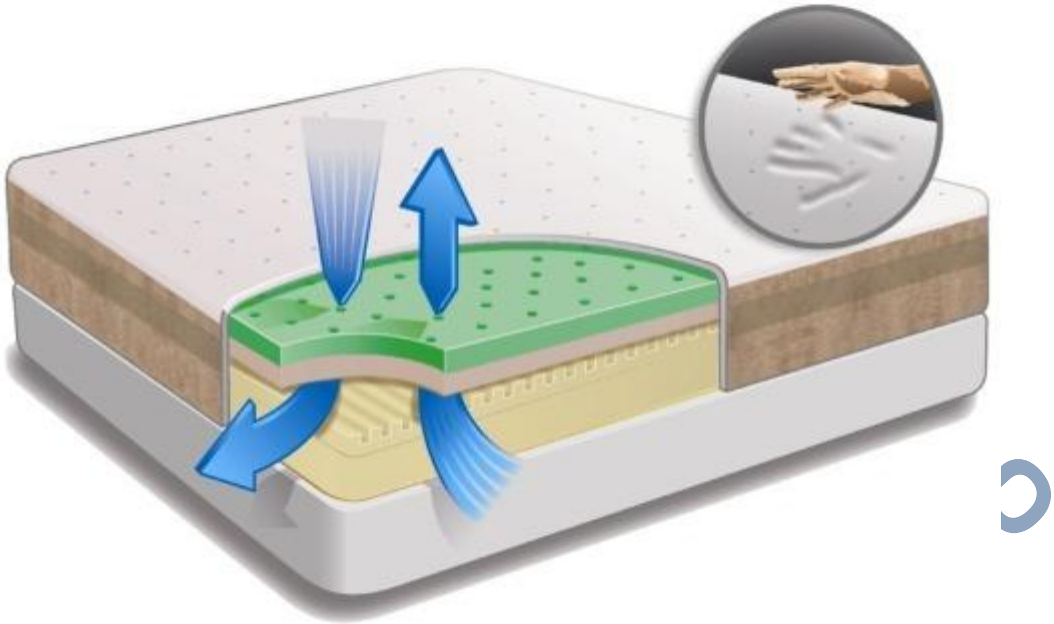


Piezoelectricity is the ability of some materials (notably crystals and certain ceramics, including bone) to generate an electric field or electric potential in response to applied mechanical stress. The effect is closely related to a change of polarization density within the material's volume. These materials expand or contract when subjected to a potential difference. Example of piezoelectric ceramics are quartz ,pb ,zr titanate

Application of piezoelectric ceramics are :-

- Sonic and ultrasonic microphones, transducers
- Sonic and ultrasonic speakers (sounders, buzzers, beepers)
- Depth sounders
- Fish Finders
- Vibration sensors
- Actuators
- Shock sensors
- Gas Igniters
- Remote controls
- Nebulizers
- Ultrasonic cleaners
- Piezo Motors
- Home security
- Tilt sensor

VISCOELASTIC MATERIAL



Viscous materials, like honey, resist shear flow and strain linearly with time when a stress is applied. Elastic materials strain instantaneously when stretched and just as quickly return to their original state once the stress is
both viscous and elastic characteristics when undergoing deformation removed. Viscoelastic materials have elements of both of these properties and, as such, exhibit time dependent strain. Whereas elasticity is usually the result of bond stretching along crystallographic planes **Viscoelasticity** is the property of materials that exhibit in an ordered solid, viscosity is the result of the diffusion of atoms or molecules inside an amorphous material

APPLICATION OF VISCOELASTIC MATERIAL

1 Damping treatment3.

1. ***Free-layer damping (FLD)***
2. ***Constrained-layer damping (CLD)***
3. ***Tuned viscoelastic damper (TVD)***

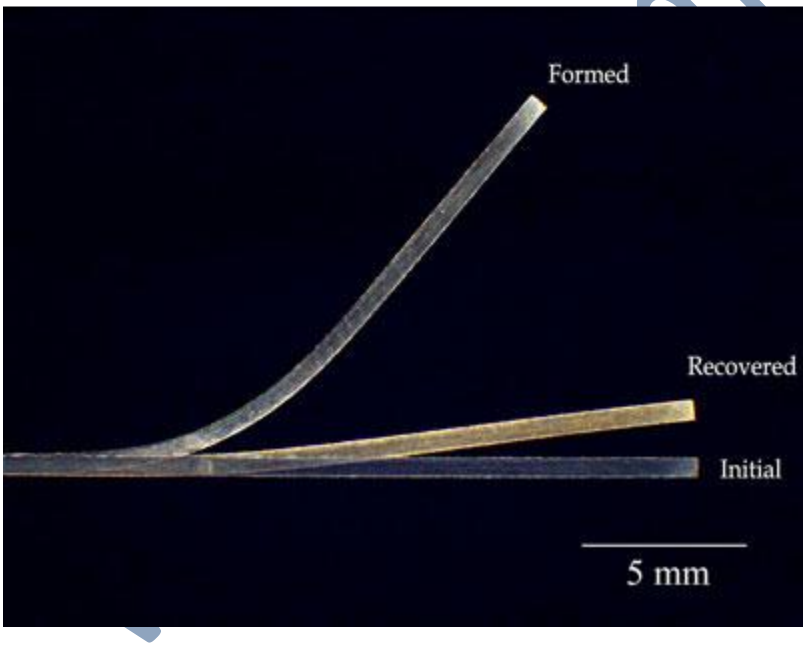
2. Automotive applications

1. ***Powertrain and body structures***

2. Laminated glass for windows

3. Commercial aircraft applications

SHAPE MEMORY ALLOYS



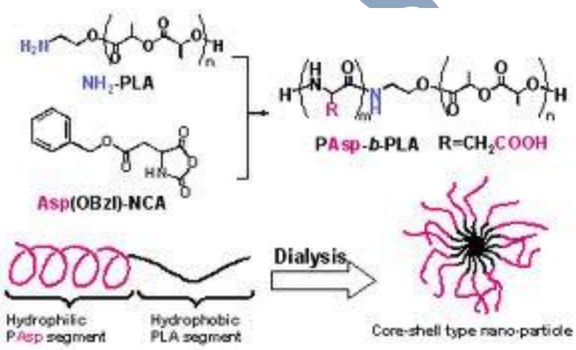
Demonstration of the shape-memory effect in a Ti(Ni,Pt) alloy. The super-imposed images are of Ti-30Ni-20Pt rolled sheet, bent 38° at room temperature, and recovered to 8° by heating to 350 °C, resulting in a displacement of the sheet end of almost 10 mm

A **shape memory alloy** (**SMA**, **smart metal**, **memory metal**, **memory alloy**, **muscle wire**, **smart alloy**) is an alloy that "remembers" its original, cold-forged shape: returning the pre-deformed shape by heating. This material is a lightweight, solid-state alternative to conventional actuators such as hydraulic, pneumatic, and motor-based systems. Shape memory alloys have applications in industries including medical and aerospace. The three main types of shape memory alloys are the copper-zinc-aluminium-nickel copper-aluminium-nickel, and nickel-titanium (NiTi) alloys but SMA's can also be created by alloying zinc, copper,gold, and iron. NiTi alloys are generally more expensive and change from austenite to martensite upon cooling; M_f is the temperature at which the transition to Martensite is finished during cooling. Accordingly, during heating A_s and A_f are the temperatures at which the transformation from Martensite to Austenite starts and finishes. Repeated use of the shape memory effect may lead to a shift of the characteristic transformation temperatures (this effect is known as functional fatigue, as it is closely related with a change of microstructural and functional properties of the material).

The transition from the martensite phase to the austenite phase is only dependent on temperature and stress, not time, as most phase changes are, as there is no diffusion involved. Similarly, the austenite structure gets its name from steel alloys of a similar structure. It is the reversible diffusionless transition between these two phases that allow the special properties to arise. While martensite can be formed from austenite by rapidly cooling carbon-steel, this process is not reversible, so steel does not have shape memory properties.

ELECTRO AND MAGNETO-RHEOSTATIC MATERIAL

PH SENSITIVE POLIMERS



polymeric micelle showed **pH sensitive** change in diameter.

ECONOMICAL OUTLOOK

- **1 Billion dollar market**

- **75% - Electro-ceramics**
- **10% -Shape Memory Materials**
- **10% - Magnetostrictive materials**
- **5% - Active Fluids**

CONCLUSION

Sensors are playing a vital role in all sorts of sciences. Hence, instead of placing various sensors at variable places in various application areas, it may be better to embed these sensors in humanoids and it could be effectively used in detecting, monitoring, message conveying, repairing etc., Thus the mobility of humanoids may be used effectively. A smart intelligent structure includes distributed actuators, sensors and microprocessors that analyze the response from the sensors and use distributed parameter control theory to command actuators, to apply localized strains. A smart structure has the capacity to respond to a changing external environment such as loads, temperatures and shape change, as well as to varying internal environment i.e., failure of a structure. This technology has numerous applications much as vibration and buckling control, ape control, damage assessment and active noise control. Smart structure techniques are being increasingly applied to civil engineering structures for health monitoring of buildings with strain and corrosion sensors.A Smart material are just starting to emerge from the laboratory, but soon you can expect to find in everything from laptop computers to concrete bridges

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