Department of Physics

(Shri Lal Bahadur Shastri Degree College, Gonda)

A One Day Seminar

Under Intellectual Property Rights

Organized

By Department of Physics

On

Smart Materials

May 15, 2024

[Seminar Report]

SHRI LAL BAHADUR SHASTRI DEGREE COLLEGE, GONDA

श्री लाल बहादुर शास्त्री डिग्री कॉलेज, गोंडा

(An Affiliated College of Dr Ram Manohar Lohiya Avadh University, Ayodhya, (U.P.))

Department of Physics

One Day Seminar Under Intellectual Property Rights

(May 15, 2024)

On

Smart Materials

Organized By

Department of Physics

(Shri Lal Bahadur Shastri Degree College, Gonda)

Inaugural Lecture

By

Prof. P. K. Singh
(Department of Physics)

(M.L.K.P.G. College, Balrampur, U.P.)

(10:00 AM to 11:00 AM)

High Tea

(11:00 AM to 11:30 AM)

Keynote Speakers

Lecture I	Lecture II		Lecture III	Lecture IV
(11:30 AM to 12:30 PM)	(12:30 AM to 01:30 PM)		(02:30 PM to 03:15 PM)	(03:15 PM to 04:00 PM)
Prof. R.K. Pandey	Dr. Pankaj Tripathi	Lunch Break	Prof. A.K. Dwivedi	Prof. Jitendra Singh
Department of Botany	Department of Physics	(01:30 PM to 02:30 PM)	Department of Physics	Department of Physics
S.l.B.S.Degree College,Gonda	Amity University, Noida		M.L.K.P.G. College, Balrampur	S.l.B.S.Degree College,Gonda

Venue

Conference Hall Department of Physics, S. L. B. S. Degree College, Gonda

Chief Patron Varsha Singh (Vice-President)	**Patron** Shri Umesh Shah (Secretary)
President Prof. R.K. Pandey (Principal)	**Convener** Prof. Jitendra Singh (Head, Department of Physics)
Organizing Secretary Dr. Santosh Kumar Srivastava (Assistant Professor, Department of Physics)	**Organizing Secretary** Dr. Dev Narayan Pandey (Assistant Professor, Department of Physics)
Organizing Secretary Dr. Avneesh Mishra (Assistant Professor, Department of Physics)	

Organizing Committee:

Mr. Shobhit Maurya	Miss Anuradha Gupta

Advisory Board	Local Scientific Advisory Board
Prof. Ravindra Dhar, University of Allahabad	Prof. Vandana Saraswat, SLBSDC, Gonda
Prof. S. K.Pandey, Head, Deptt. Of Mathematics,	**Dr. Rekha Sharma, Deptt. of Botany**
Prof. Mukul Sinha, Head, Deptt. Of Zoology	**Prof. Atul Kumar Singh, SLBSDC, Gonda**
Prof. Binod PratapSingh, SLBSDC,Gonda	**Dr Ankit Maurya**
Prof.Aman Chandra, SLBSDC, Gonda	**Sri Manish Sharma, Deptt. of Mathematics**
Prof. Vijay Kr Agrawal, SLBSDC, Gonda	**Sri Shishir Tripathi, Deptt .of Zoology**
Prof. Shiv Sharan Shukla, SLBSDC, Gonda	**Dr. Vivek Kumar Khare, SLBSDC, Gonda**
Prof. B. Singh Baghel, SLBSDC, Gonda	**Dr. Sanjay Kumar Verma, SLBSDC, Gonda**
Prof. Rajeev Kr Agrawal, SLBSDC, Gonda	**Dr. Satish Kumar Tiwari, SLBSDC, Gonda**
Prof. A. K. Srivastava, SLBSDC, Gonda	**Dr. Ashok Kumar Pandey, SLBSDC, Gonda**
Prof. J. B. Pal, SLBSDC, Gonda	**Dr. Smita Singh, SLBSDC, Gonda**
Prof. S. B. Singh, SLBSDC, Gonda	**Dr. Dharmendra Pratap Singh, SLBSDC, Gonda**
Prof. V.C H. N K S. Rao, SLBSDC, Gonda	**Dr. Chaman Kaur, SLBSDC, Gonda**
Prof. Shyam Bahadur Singh, SLBSDC, Gonda	**Dr. Neeraj Yadav, SLBSDC, Gonda**
Prof. Rishikesh Singh, SLBSDC, Gonda	**Dr. Vinay Kumar Pandey, SLBSDC, Gonda**
Prof. Mansha Ram Verma, SLBSDC, Gonda	**Dr. Priyanka Srivastava, SLBSDC, Gonda**
Prof. Alok Shukla, MLKPG College, Balrampur	**Mr. Awadhesh K. Verma, SLBSDC, Gonda**
Prof. Rishikesh Singh, SLBSDC, Gonda	**Mr. Abhay Dwivedi, SLBSDC, Gonda**
Prof. VCHNK Srinivas Rao, SLBSDC, Gonda	**Mr. Shobhit Maurya, SLBSDC, Gonda**
Prof. S. K. Srivastava, SLBSDC, Gonda	**Mr. L. Kalyani, SLBSDC, Gonda**
Prof. Sandeep Kumar Srivastava, SLBSDC, Gonda	**Mr. Om Prakash Yadav, SLBSDC, Gonda**
Mr .Pawan Kumar Singh, SLBSDC	**Dr. Achyut Shukla, SLBSDC, Gonda**
Dr. Shailesh Kumar, SLBSDC, Gonda	**Dr. Arun Pratap Singh, SLBSDC, Gonda**
Dr. Dalip Kumar, Singh SLBSDC, Gonda	**Dr. Rachna Srivastava, SLBSDC, Gonda**
Dr .Ramint Patel, SLBSDC, Gonda	**Dr. Shailja Singh, SLBSDC, Gonda**
Dr. Ajeet Kumar Mishra, SLBSDC, Gonda	**Dr. Smriti Shishir, SLBSDC, Gonda**
Dr. Mamta Shukla, SLBSDC, Gonda	**Dr. Neetu Saxena, SLBSDC, Gonda**
Dr. Raj Bahadur Chaudhary, SLBSDC, Gonda	**Dr. Manisha Pal, SLBSDC, Gonda**
Prof. S. K. Srivastava, Head, Deptt. Of Botany	**Dr. Harish Kumar Shukla, SLBSDC, Gonda**

A One Day Seminar

Under Intellectual Property Rights

Organized

By

Department of Physics

On

Smart Materials

(May 15, 2023)

The objectives of this seminar were to study the current practices related to the various smart materials developed and needs for future technology development in India for human wellbeing. The other purpose is to developed research ideology in post graduate students in India. This report is based on secondary research as per the suggestions given by speakers. Existing reports related to synthesis and their electrical, biological, optical requirements of smart materials in present and future technologies were discussed. It offers deep knowledge about the synthesis and their electrical, biological, optical, magnetic and other physical properties of smart materials and find out the scope for improvement of properties of existing materials for the welfare of the society. The seminar attempts to understand the important role of smart materials in development of new device or technology for students, staff and teachers in our country. This work is original and could be further extended.

Introduction

`Smart' materials have the capability to perform both sensing and actuating functions. Passively smart materials respond to external change in a useful manner without assistance, while actively smart materials have a feedback loop which allows them to both recognize the change and pledge an appropriate response through an actuator circuit. One of the techniques used to impart intelligence into materials is `Biomimetics', the imitation of biological functions in engineering materials. Composite ferroelectrics shaped after the lateral line and swim bladders of fish are used to illustrate this idea. `Very smart' materials, in addition to actuating and sensing, have the ability to `learn' by altering their property coefficients in response to the environment. Field-induced changes in the nonlinear properties of relaxor ferroelectrics and soft rubber are utilized to construct tunable transducers. These different technologies into compact, multifunction packages is the ultimate goal of research in the area of smart materials. Materials that have one or more properties that can be significantly changed in a controlled fashion by external stimuli, such as stress temperature electric, optic, electro-optic and magnetic fields. **The main advantages of the smart materials are the following:** (i) No moving parts, High reliability, Low power requirements, etc. (ii) High energy density (compared to pneumatic and hydraulic actuators) (iii) Excellent bandwidth Classification of Smart Materials Actuating Materials (iv) Electrorheological Fluids (ER Fluids) (v) Shape Memory Alloys (SMA) Sensing Materials (vi) Fiber Optic (F.O.) sensors Dual-Purpose Materials (Actuating & Sensing) (vii) Magneto strictive, Materials Piezoelectric, Materials.

CLASSIFICATION:

Controllable fluids: Electro rheological, Magneto rheological, Biomimetic polymers and gels, Fullerenes and carbon nanotubes.

PIEZOELECTRIC MATERIALS:- The piezoelectric effect describes the relation between a mechanical stress and an electrical voltage in solids. It is reversible material: an applied mechanical stress will generate a voltage and an applied voltage will change the shape of the solid by a small amount (up to a 4% change in volume). In physics, the piezoelectric effect can be described as the the link between electrostatics and mechanics. History: The piezoelectric effect was discovered in 1880 by the Jacques and Pierre Curie brothers. They found out that when a mechanical stress was applied on crystals such as tourmaline, tourmaline, topaz, quartz, Rochelle salt and cane sugar, electrical charges appeared, and this voltage was proportional to the stress. First applications were piezoelectric ultrasonic transducers and soon swinging quartz for standards of frequency (quartz clocks). **An everyday life application example is your car's airbag sensor.** The material detects the intensity of the shock and sends an electrical signal which triggers the airbag.

Piezoelectric materials: The piezoelectric effect occurs only in non conductive materials. Piezoelectric materials can be divided in 2 main groups: crystals and ceramics. The most well-known piezoelectric material is quartz (SiO_2)**.**

ELECTROSTRICTIVE MATERIALS: Electrostrictive materials can also change their dimensions on the application of an electric field. These materials have widespread application in medical and engineering fields. Electrostriction is a property of all dielectric materials, and is caused by the presence of randomly-aligned electrical domains within the material. When an electric field is applied to the dielectric, the opposite sides of the domains become differently charged and attract each other, reducing material thickness in the direction of the applied field (and increasing thickness in the orthogonal directions due to Poisson's ratio). The resulting strain (ratio of deformation to the original dimension) is proportional to the square of the polarization. The properties of DC biased resonators of this 5material are derived from a nonlinear theory based on the Taylor's series expansion of the thermodynamic potentials to 3rd and higher order terms in field and stress.

MAGNETOSTRICTIVE MATERIAL: These materials are quite similar to Electrostrictive materials, except for the fact that they respond to magnetic fields. The most widely used Magnetostrictive material is TERFENOL-D, which is made from the rarest of the rare earth elements, i.e. Terbium. This material is highly non-linear and has the capability to produce large strains. Magnetostrictive (MS) technology and Magneto-Rheological Fluid (MRF) technology are old “newcomers” coming to the market at high speed. **Industries including the automotive industry are full of potential MS and MRF applications.** Magnetostrictive technology and MagnetoRheological Fluid technology have been successfully employed already in various low and high volume applications. **MRF technology, direct shear mode (used in brakes and clutches) and valve mode (used in dampers) have been studied thoroughly and several applications are already present on the market. Excellent features like fast response, simple interface between electrical power input and mechanical power output, and precise controllability make MRF technology attractive for many applications.**

Magnetostriction effects Crystals of ferromagnetic materials change their shape when they are placed in a magnetic field.. This phenomenon is called magnetostriction. It is related to various other physical effects. Magnetostriction is, in general, a reversible exchange of energy between the mechanical form and the magnetic form. The ability to convert an amount of energy from one form into another allows the use of magnetostrictive materials in actuator and sensor applications.

RHEOLOGICAL MATERIALS: These fluids may find applications in brakes, shock absorbers and dampers for vehicle seats. These can be fitted to buildings and bridges to suppress the damaging effects, for example, high winds or earthquakes.

Rheological Materials: Rheology is the study of the flow of matter: primarily in the liquid state, but also as 'soft solids' or solids under conditions in which they respond with plastic flow rather than deforming elastically in response to an applied force. It applies to substances which have a complex molecular structure, such as muds, sludges, suspensions, polymers and other glass formers (e.g. silicates), as well as many foods and additives, bodily fluids (e.g. blood) and other biological materials. **Ketchup can have its viscosity reduced by shaking (or other forms of mechanical agitation) but water cannot. Since Sir Isaac Newton originated the concept of viscosity, the study of variable viscosity liquids is also often called non-Newtonian fluid mechanics.**

THERMORESPONSIVE MATERIALS: Thermoresponsive materials are sometimes also known as shape memory alloys or shape memory polymers. These materials alter their shape under the influence of the ambient temperature. Magnetic Shape Memory Alloys Like thermoresponsive materials that alter their shape under the influence of the ambient temperature, magnetic shape memory alloys change shape due to changes in magnetic fields. Polychromic, Chromogenic or Halochromic Materials Polychromic, chromogenic and halochromic materials all change colour due to external influences. **Materials that change colour due to temperature are normally known as thermochromic materials and those that alter due to light are photochromic materials.**

Applications of Smart Nanomaterials: Smart nanomaterials are expected to make their presence strongly felt in areas like: Healthcare, with smart materials that respond to injuries by delivering drugs and antibiotics or by hardening to produce a cast on a broken limb. Implants and prostheses made from materials that modify surfaces and biofunctionality to increase biocompatibility **Energy generation and conservation with highly efficient batteries and energy generating materials. Security and Terrorism Defence with smart materials that can detect 11toxins and either render them neutral, warn people nearby or protect them from it.** Smart textiles that can change colour, such as camouflage materials that change colour and pattern depending upon the appearance of the surrounding environment. These materials may even project an image of what is behind the person in order to render them invisible. Surveillance using “Smartdust” and “Smartdust Motes” that are nanosized machines housing a range of sensors and wireless communication devices. Individually they can float undetected in a room with other dust particles. By combining the information gathered from hundreds, thousands or millions of these tiny specs can give a full report on what is occurring with the area including sound and images**.**

ELECTROCHROMIC MATERIALS: Electrochromism is the phenomenon displayed by some materials of reversibly changing color when a burst of charge is applied. Various types of materials and structures can be used to construct electrochromic devices, depending on the specific applications. One good example of an electrochromic material is polyaniline which can be formed either by the electrochemical or chemical oxidation of aniline. If an electrode is immersed in hydrochloric acid which contains a small concentration of aniline, then a film of polyaniline can be grown on the electrode. Depending on the oxidation state, polyaniline can either be pale yellow or dark green/black. Other electrochromic materials that have found technological application include the viologens and polyoxotungstates. Other electrochromic materials include tungsten oxide (WO3), which is the main chemical used in the production of electrochromic windows or smart glass. Polymer-based solutions have recently been developed by John Reynolds and colleagues at the University of Florida. These promise to provide flexible and cheap electrochromics in a variety of colours, going all the way up to black. **Electrochromic Materials As the color change is persistent and energy need only be applied to effect a change, electrochromic materials are used to control the amount of light and heat allowed to pass through windows ("smart windows"), and has also been applied in the automobile industry to automatically tint rear-view mirrors in various lighting. Viologen is used in conjunction with titanium dioxide (TiO2) in the creation of small digital displays.** It is hoped that these will replace liquid crystal displays as the viologen, which is typically dark blue, has a high contrast compared to the bright white of the titania, thereby providing the display high visibility. ICE 3 high speed trains use electrochromatic glass panels between the passenger compartment and the driver's cabin.

APPLICATION: Fast response valves, High power density hydraulic pumps Active bearings for reduction of machinery noise Footwear Sports equipment Precision machining Vibration and acoustic sensors Dampers, etc. Healthcare, with smart materials that respond to injuries by delivering drugs and antibiotics or by hardening to produce a cast on a broken limb. Energy generation and conservation with highly efficient batteries and energy generating materials. Security and Terrorism Defence with smart materials that can detect toxins and either render them neutral, warn people nearby or protect them from it. Smart textiles that can change colour, such as camouflage materials that change colour and pattern depending upon the appearance of the surrounding environment. These materials may even project an image of what is behind the person in order to render them invisible. Surveillance using “Smartdust” and “Smartdust Motes” that are nanosized machines housing a range of sensors and wireless communication devices. Individually they can float undetected in a room with other dust particles. By combining the information gathered from hundreds, thousands or millions of these tiny specs can give a full report on what is occurring with the area including sound and images. **CONCLUSION: This seminar is highly knowledgeable, inspiring and motivative for Post graduate students. Among of teachers and staff was aware about the different technologies and other advanced instruments. Students was gaining more knowledge**

about the smart materials used in daily appliances. Overall, these seminar was completely adopt there objectives.

Photo1. Inaugural Lecture by Prof. P. K. Singh (in left) & Students in Conference Hall (in right).

Photo2. B.Sc & M.Sc Students hearing Lecture (in left) & Prof. P. K. Singh on Podium (in right).