Overview of the Course

Shape memory materials are a class of materials that remember their shape. Shape memory alloys undergoing martensitic transformation are metals belonging to this class. A part of applied strain on these materials can be recovered either by releasing the applied stress or by an additional external stimulus (e.g. heating) giving rise to superelasticity and shape memory phenomena. The exploitation of these phenomena needs to be based on detailed knowledge of the physics and mechanics of diffusionless martensitic transformation in solid-state.

Nitinol (Ni-Ti intermetallic alloy) is commercially the most successful shape memory alloy – it has already been used in many engineering applications in medical devices, robotics or space industry. NiTinol can recover up to 6 % inelastic strain in polycrystalline form. Copper-based shape memory alloys can recover up to 17% strain in single crystalline form, but only ~3% in polycrystalline form and polycrystalline materials suffer from limited fatigue properties in cyclic loads. Fe-based SMAs shows mainly shape memory effect and recovery stress generation on heating. Ferromagnetic SMAs as NiMnGa are responsive also to a magnetic field. High-temperature HTSMAs with transformation temperatures above 100°C as e.g. NiTiHf alloy have been under development in the last decade.

Currently, automobile, civil engineering, and aerospace industries requires materials with more functional properties. Although SMAs have enormous potential in this respect, further research is needed to develop the existing application ideas into reliably functioning products, which requires a strongly multidisciplinary approach. Hence, the dissemination of knowledge on this kind of material is required. The purpose of this GIAN course is to create such a knowledge base and awareness among the engineers and research scholars.

Course outcomes

At the end of the course, the participant will be able to

- Appreciate the potential of shape memory materials as a functional material.
- Explain the mechanisms of shape memory materials
- Classify shape memory materials (alloys, polymers and ceramics)
- Discuss the applications and limitations of selected SMAs.
- Fabricate simple devices using Ni-Ti shape memory alloy wires/ springs.

Course contents

Day 1: Introduction to martensitic transformations in SMAs; Martensitic transformations in thermomechanical experiments on Cu based single crystals; Martensitic transformations in CuAlZnMn polycrystals under general thermomechanical loads; Microstructural characterization of SMAs; Lab session on structural characterization.

Day 2: Martensitic transformations in NiTinol; Coupling of martensitic transformation and dislocation slip in NiTi at high stresses and temperatures; HTSMAs; Mechanical characterization of SMAs; Lab session on mechanical characterization

Day 3: In-situ x-ray (neutron) diffraction of deformation processes in NiTi; In-situ electric resistance and infrared camera studies of deformation processes in NiTi; Shape memory polymers, gels, hybrids and composites- basics, mechanisms and applications; Simple device fabrication using SMAs (Session-1).

Day 4: Localized deformation of NiTi in tension; TEM analysis of lattice defects created by tensile deformation of NiTi; SMAs in aerospace applications; Simple device fabrication using SMAs (Session-2).

Day 5: Modelling of thermomechanical behavior of NiTi; NiTi textiles; Examination; Feedback

Who can attend?

Scientists and researchers from government research organizations
Faculty from academic institutes
Engineers from industry
Students at all levels (B.Tech/ M.Tech/ MSc/ PhD)

How to reach NITW?

Nearby airport: Rajiv Gandhi International airport (3hours journey from Warangal)
Nearby railway station:
Kazipet (KZJ) 3 km from NIT, Warangal
Warangal (WL) 12 km from NIT, Warangal

शिक्षा मंत्रालय
MINISTRY OF
EDUCATION
सत्यमेव जयते

GIAN
GLOBAL INITIATIVE OF ACADEMIC NETWORKS

5-days GIAN course on

Shape Memory Materials

Basics and Applications

(Course ID:191036L03)

13-17 February 2023

International Faculty

Prof. Petr Šittner
Institute of Physics of the CAS
Czech Republic

Indian Faculty

Dr. D I Arun
Scientist, VSSC-ISRO

Coordinators

Dr. R. Arockia Kumar
Dr. B. Srinivasa Rao

Organized by

Metallurgical and Materials Engineering Department
National Institute of Technology Warangal
(An Institute of National Importance)
Warangal-506 004, Telangana State, India

About the Institute

National Institute of Technology Warangal, formerly known as Regional Engineering College was established in1959. Over the years it has developed into a premier institute of higher learning and is ranked among the top technical education institutions in India. There are 14 Departments offering eight undergraduate and 31 post- graduate programmes besides doctoral programmes. About 5000 students across the country and about 500 international students' study in the campus. It is a fully residential campus sprawling over 250 acres with excellent infrastructure.

About the Department

The Department of Metallurgical and Materials Engineering (MME) was established in the year 1965 and presently offers an undergraduate program in MME and two postgraduate programs with specialization in Industrial Metallurgy and Materials Technology. The department is consistently receiving accreditation by NBA since past several years for its excellent academic and research activities. The department has experienced faculty and well-established laboratories with state-of-the-art facilities in various areas of research. The department also offers PhD programme in MME and presently about 40 scholars are working in key areas of research. The department is also in collaborative research with organizations such as DMRL, ARCI, IGCAR, BARC, BHEL, NTPC, ISRO etc. Presently the department is engaged with research projects received from DAE-BRNS, DRDO-NRB, ARDB, AUSC Mission Directorate, UGC-DAE etc.

About Warangal

Warangal is about 135km from Hyderabad, the capital of Telangana. It is well connected by rail and road. It is well known as an educational centre. Once, the capital of the great Kakatiya Kingdom and earlier known as Orugallu or Ekasilanagaram, Warangal still retains its importance as the cultural centre of the Telangana. It finds an important place in the tourist map of Telangana with sites of archaeological significance like the Warangal fort, Thousand Pillars temple, Bhadrakali templeand Ramappa temple. The three lakes namely Ramappa, Pakhal and Laknavaram and the wild life sanctuaries at Tadwai and Pakhal are famous for sightseeing.

About GIAN

About GIAN Course: Ministry of Human Resource Development (MHRD), Government of India (GoI) has launched an innovative program titled "Global Initiative of Academic Networks (GIAN)" in higher Education, in order to garner the best international experience. As part of this, internationally renowned Academicians and Scientists are invited to augment the Country's academic resources, accelerate the pace of quality reforms and elevate India's scientific and technological capacity to global excellence.

How to register for the course?

Stage-1: Web Portal Registration:

Visit http://www.gian.iitkgp.ac.in/GREGN/index and create login User ID and Password. Fill up the registration form and complete web registration by online payment of Rs. 500/-. This provides the user with life time registration to enroll in any number of GIAN courses offered.

Stage-2: Course Registration:

Login to the GIAN portal with the user ID and Password already created in Step 1. Click on Course Registration option at the top of Registration form. Select the Course titled "Shape Memory Materials-Basics and Applications" from the list and click on save option. Confirm your registration by clicking on "Confirm Course". Course will be offline.

Registration charges

Students	Rs.1500/-
Students with the award of grade	Rs. 2000/-
Faculty and Scientists	Rs. 2000/-
Industry participant	Rs. 5000/-
Participant from abroad	USD 400

The above fees include all instructional materials, computer use for tutorials, free internet facility, tea and snacks. The course fee is inclusive of 18% GST as per institute norm. The participants may avail single bedded shared accommodation and food (breakfast, lunch and dinner) if requested on an additional payment basis.

Details for NEFT

Account Name	GIAN NITW
Account No.	62447453600
Bank	State Bank of India
Branch	REC Warangal (NIT Campus)
Branch Code	20149
IFSC	SBIN0020149
MICR Code	506002030
SWIFT Code	SBININBB

Note: For confirmation of registration, the proof of payment (a scanned copy Demand Draft/NEFT transaction details) along with the registration form and copy of PDF generated at GIAN portal (if registered through GIAN portal) are to be e-mailed to **arockia@nitw.ac.in**; Candidates registering early will be given preference in short listing process; For any queries regarding registration of the course, please contact the course coordinator

Accommodation

The participants will be provided boarding and lodging on payment basis. In view of limited availability of rooms, accommodation will be provided on first come first serve basis. Participants will not be entitled for payment of any TA/DA.

Foreign faculty

Dr. Petr Šittner has been involved in the research of martensitic transformations and related phenomena in solids and functional materials, particularly Shape Memory Alloys since 1991. He is currently Head of the Condensed Matter Division of the Institute of Physics of the CAS, in Prague Czech Republic. He has founded and built the SMA research lab with his colleague Vaclav Novak in the Institute of Physics CAS in 1995. The lab has gradually developed into the present Department of Functional Materials and Composites hosting 3 research groups. At present, he is working on the development of x-ray and neutron diffraction methods applicable to SMAs, fatigue of NiTi actuators, nonconventional heat treatment and shape setting of NiTi and environmental fatigue of NiTi for medical devices. He published over 200 scientific articles in impacted journals, 2 book chapters, and 3 patents to his credit. He served as a member of the Board of Directors of the SMST ASM International, chairman of international conferences ESOMAT 2009 and SMST 2013 in Prague. He also serves as Associated editor of the Shape Memory and Superelasticity journal.

Indian faculty

Dr D I Arun is a Scientist at Vikram Sarabhai Space Centre, ISRO and he is responsible for design and realization of Composite overwrapped metal-lined gas bottles for ISRO spacecraft missions. He also specializes in shape memory polymers. He has authored a book Shape Memory Materials published by CRC press. His research interest includes application of smart materials and structures as replacement for the current complex spacecraft mechanisms, shape memory polymer nanocomposites, shape memory gels, carbon based multifunctional materials for space applications.

About laboratory sessions

This course is being offered with laboratory sessions in which participants will be trained to heat treat shape memory alloys which would led to development of springs and two-way shape memory behavior.

For any queries, please contact

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Last date for registration: 30 Jan 2023