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35 YEARS OF EXCELLENCE IN MEDICAL PUBLISHING

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Crystallographic Aspects of Reversibility in Shape Memory Alloys

The shape memory effect is a peculiar property exhibited by a series of alloy systems called shape memory alloys. These alloys are temperature-sensitive materials, and undergo structural changes, with crystallographic reactions called martensitic transformations with the variation of temperature and deformation. The shape memory effect is initiated by cooling and deformation processes and performed thermally on heating and cooling after these treatments. Strain energy is stored in the material with deformation and released upon heating, by recovering the original shape in bulk level, and cycles between original and deformed shapes on heating and cooling in a reversible way. The shape memory effect is performed thermally in a temperature interval depending on the forward and reverse transformation, on cooling and heating, respectively, and this behavior is called thermoelasticity. The shape memory effect is governed by thermal and stress-induced martensitic transformations. Thermal induced martensitic transformation occurs on cooling with the cooperative movement of atoms in <110>-type directions on {110}-type close-packed planes of austenite matrix, by means of shear-like mechanism, and ordered parent phase structures turn into the twinned martensite structure with lattice twinning. Twinned structures turn into detwinned structures by means of stress-induced martensitic transformation with the deformation.

These alloys exhibit another property called superelasticity, which is performed in only a mechanical manner. These alloys are stressed in the parent phase region just over austenite finish temperature and recover the original shape simultaneously and instantly on releasing the external forces. Superelasticity is also the result of stress-induced martensitic transformation, and parent austenite phase structures turn into the fully detwinned martensite with the stressing. Superelasticity exhibits ordinary elastic material behavior, but it is performed in a non-linear way; loading and unloading paths are different at the stress-strain diagram, and hysteresis loop refers to energy dissipation.

Copper-based alloys exhibit this property in the metastable β-phase region, which has bcc-based structures. Lattice invariant shears and twinning are not uniform in these alloys, and the ordered parent phase structures martensitic alloy undergo the non-conventional complex layered structures. The long-period layered structures can be described by different unit cells as 3R, 9R, or 18R depending on the stacking sequences on the close-packed planes of the ordered lattice. The unit cell and periodicity are completed through 18 layers in direction z, in the case of 18R martensite, and unit cells are not periodic in short-range in direction z.

In the present contribution, x-ray diffraction and transmission electron microscopy studies were carried out on two copper-based CuZnAl and CuAlMn alloys. X-ray diffraction profiles and electron diffraction patterns exhibit superlattice reflections inherited from the parent phase due to the diffusion less character of martensitic transformation. X-ray diffractograms took in a long-time interval show that diffraction angles and intensities of diffraction peaks change with the aging time at room temperature. This result refers to a new transformation in a diffusive manner.

Keywords: Shape memory effect, martensitic transformation, thermoelasticity, superelasticity, lattice twinning, and detwinning.

Biography

Osman Adiguzel is graduated from the Department of Physics, Ankara University, Turkey in 1974 and received Ph D.- degree from Dicle University, Diyarbakir- Turkey. He has studied at Surrey University, Guildford, UK, as a post-doctoral research scientist in 1986-1987, and studied shape memory alloys. He worked as a research assistant, 1975-80, at Dicle University and shifted to Firat University, Elazig, Turkey in 1980. He became a professor in 1996, and he has been retired on November 28, 2019, due to the age limit of 67, following academic life of 45 years.

He published over 80 papers in international and national journals; He joined over 120 conferences and symposia at the international and national level as a participant, invited speaker, or keynote speaker with contributions of oral or poster. He served as the program chair or conference chair/co-chair in some of these activities. In particular, he joined in last six years (2014 - 2019) over 60 conferences as Keynote Speaker and Conference Co-Chair organized by different companies. Also, he joined over 70 online conferences in the same way in the pandemic period of 2020-2021. He supervised 5 Ph.D.- theses and 3 M. Sc- theses.

Osman Adiguzel served as his directorate of Graduate School of Natural and Applied Sciences, Firat University, in 1999-2004. He received a certificate awarded to him and his experimental group in recognition of the significant contribution of 2 patterns to the Powder Diffraction File – Release 2000. The ICDD (International Centre for Diffraction Data) also appreciates the cooperation of his group and interest in the Powder Diffraction File.

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Raman Singh

Monash University, Melbourne, Australia

Graphene Coatings - A Disruptive Approach for Mitigation of Environment-assisted Degradation

Corrosion and its mitigation costs dearly (any developed economy loses 3-4% of GDP due to corrosion, which translates to ~$250b to annual loss USA). In spite of traditional approaches of corrosion mitigation (e.g., use of corrosion resistance alloys such as stainless steels and coatings), loss of infrastructure due to corrosion continues to be a vexing problem. So, it is technologically as well as commercially attractive to explore disruptive approaches for durable corrosion resistance.

Graphene has triggered unprecedented research excitement for its exceptional characteristics. The most relevant properties of graphene as a corrosion resistance barrier are its remarkable chemical inertness, impermeability, and toughness, i.e., the requirements of an ideal surface barrier coating for corrosion resistance. However, the extent of corrosion resistance has been found to vary considerably in different studies. The author’s group has demonstrated an ultra-thin graphene coating to improve the corrosion resistance of copper by two orders of magnitude in an aggressive chloride solution (i.e., similar to sea-water)1. In contrast, other reports suggest the graphene coating actually enhances corrosion rate of copper, particularly during extended exposures. The author's group has investigated the reasons for such contrast in corrosion resistance due to graphene coating as reported by different researchers. On the basis of the findings, the author’s group has succeeded in demonstrating durable corrosion resistance as a result of the development of suitable graphene coating. The presentation will also assess the challenges in developing corrosion-resistant graphene coating on most common engineering alloys, such as mild steel, and presents results demonstrating circumvention of these challenges

Biography

Raman Singh is a professor in the Chemical and Biological Engineering Department, Monash University His research expertise includes Alloy Nano/Microstructure-Corrosion Relationship, stress corrosion cracking (SCC), Corrosion/SCC of Biomaterials, Corrosion Mitigation by Novel Material (e.g., Graphene), Advanced and Environmentally Friendly Coatings, High-Temperature Corrosion. He has supervised 50 Ph D. students. He has published over 250 peer-reviewed international journal publications, 15 books/book chapters, and over 100 reviewed conference publications. His professional responsibilities include editor-in-chief of two journals, Fellow ASM International and Engineers Australia, over 40 keynote/plenary talks at international conferences (besides numerous invited talks), leadership (as chairperson) of a few international conferences.

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Brunello Tirozzi

University of Rome, Italy

Magnetic Force-Free Theory: Nonlinear case

The focus of this paper deals with innovative material and construction systems that incorporate nanotechnologies for improving their energy-saving performance. Recent developments in the world of phase change materials, specifically on organic PCMs, such as paraffin and bio-PCM aerogel, are presented; laboratory works are presented together with pilot projects in Toronto, where PCM-based systems have been incorporated in high-performing buildings. Then, the paper shows recent advancements in super-insulating materials, specifically focusing on aerogel-enhanced blankets and panels, which have been developed at the BeTOP laboratory of the Ryerson University in Toronto, Ontario. Finally, the paper explores the potentialities of including innovative thermochromic coatings at the urban scale and shows the mutual benefits between buildings and communities that could be obtained through the adoption of previously mentioned nanotechnologies. The goal is to describe a pathway towards more sustainable and resilient communities. Using Toronto as a test case, the paper aims to comprehensively show that nanotechnologies offer a paradigm shift at the different scales of the built environment.

Biography

Brunello Tirozzi is a professor in the Department of Physics, University of Rome. His research interests are Elementary Particle Physics, Statistical Mechanics, Dynamical Systems, Disordered Systems Renormalization Group, Neural Networks, Neurobiology, Asymptotic methods, fluidynamics, typhoons, tsunami, Plasma Physics. He has published over 200 research papers and participated in various International Conferences.

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