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Laurent Waltz et al., Nano Res Appl, Volume:4
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EXPERIMENTAL CHARACTERIZATION OF 316L NANOCRISTALLIZED MULTILAYER STRUCTURE

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In the present work, a new method combining surface nanocrystallisation treatment (SMAT) and the co-rolling process is presented. The aim of this duplex treatment is the development of a 316L stainless steel semi-massive multilayered bulk structure with improved yield and ultimate tensile strengths, while conserving an acceptable elongation to failure by optimizing the volume fraction and distribution of the nano-grains in the laminate. To characterize this composite structure, tensile and three point bending tests have been carried out. A special attention was granted to the inspection of the interface bonding quality of the co-rolled composite laminates. Furthermore, optical and electron microscope observations were carried out to determine the correlation between the mechanical response, the microstructure and the appearance of the interfaces. Mechanical tests and microstructural observations have shown the presence of oxides at the laminate interfaces (Figure 1). It appears that the thermomechanical treatment carried out at 650°C leads to a bad junction at the interfaces, which has a detrimental effect on the mechanical strength of the structures. Moreover, the question of maintaining the nanostructured layers after thermomechanical treatment arises.

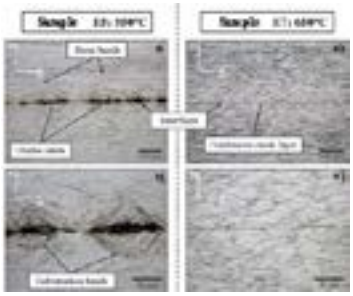

Figure1: Optical microscopy observations performed on co-rolled samples after electrolytic polishing and heat treatment of: a) and b) 550°C; a') and b') 650 °C.

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1. K. Lu, J. Lu, Surface nanocrystallization (Snc) of metallic materials - presentation of the concept behind a new approach, J. Mater. Sci. Technol. 15 (1999) 193-197.
2. K. Lu, J. Lu, Nanostructured surface layer on metallic materials induced by Surface Mechanical Attrition Treatment, Mater. Sci. Eng. A 375-377 (2004) 38-45.
3. T. Roland, D. Retraint, K. Lu, J. Lu: Generation of nanostructures on 316L stainless steel and its effect on mechanical behavior, Mater. Sci. Forum 490-491 (2005) 625-630.
4. D. Retraint, Effect of a superficial nanostructured layer on the mechanical properties of metallic parts, Matériaux & Techniques 99 (2011) 101-104.
5. L. Waltz, P. Kanouté, D. Retraint, "Mechanical characterization of a SMATed 316L stainless steel: use of cyclic nanoindentation", European Congress on Advanced Materials and Processes (Euromat 2011), Montpellier, 12-15 September 2011.
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Biography

After getting an engineer diploma in mechanical engineering and a master of science from the High Institute of Aeronautics and Space in Toulouse (France), Laurent Waltz started a PhD thesis on the development of nanocrystallized structures presenting high mechanical strength at the University of Technology of Troyes. He is currently associate professor at the Laboratory of Mechanics and Civil Engineering of Montpellier University where he works on the characterization of materials with gradient properties using optical means.

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NANO-CALCITE PREPARATION AIMED AT CONSOLIDATING STONES FOR CULTURAL HERITAGE APPLICATIONS

Luca Panariello[1], Maria-Beatrice Coltelli[1], Valter Castelvetro[1], Elisabeth Mascha[2], Johannes Weber[2] and **Andrea Lazzeri[3]**

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The consolidation of stone of ancient monuments, such as middle age cathedrals, degraded because of natural ageing, is an important topic for European cultural heritage conservation. Usually tetraethyl orthosilicate (TEOS) based treatments are used as consolidants because they lead to formation of stable amorphous silica inside stones pores. While generally effective, this treatment is more compatible with silicate stones and it shows a tendency to cracking upon drying. It shows also the tendency to induce damages because of the differential dilatation behavior with respect to host stone. To consolidate carbonatic stones, a carbonate based consolidant should be reasonably developed to improve compatibility with the host stone. Moreover, its nano dimension facilitates penetration into the stone micro-porosities, with generation of a very high surface area resulting in a high reactivity inside pores. For these reasons nano-calcite may provide a good alternative to TEOS. Nano-calcite can be prepared by the carbonation of calcium hydroxide in water in the presence of interfacial agents. This reaction is very cheap and well known, but the control of reaction parameters to achieve nano-scale dimensions is quite complex. The present work concerns the preparation of a water suspension containing nano-calcite through the controlled carbonation of calcium hydroxide in water in a pilot plant. The reaction was optimized by keeping into account a statistical approach based on a simplified design of experiment technique applied to the different reaction parameters. Thanks to this approach the role played by several parameters in determining the final morphology of the nano-calcite was investigated. The preliminary laboratory testing of nano-calcite onto a carbonate stone showed a good adhesion of nano-particles in the host stone, unveiling interesting potentiality of this treatment.

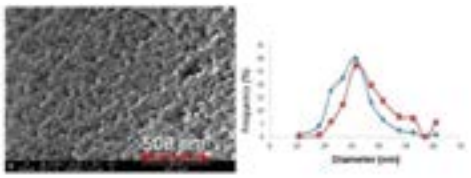

Figure 1: FESEM micrograph (left) and diameter distribution by light scattering measurements (right) related to a nano-calcite sample

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2. Shi X, Bertóti I, Pukánszky B, Rosa R and Lazzeri A. 2011) Structure and surface coverage of water-based stearate coatings on calcium carbonate nanoparticles. Journal of Colloid Interface Science 362:67-73.
3. Verganelaki A, Kilikoglou V, Karatasios I and Maravelaki-Kalaitzaki P (2014) A biomimetic approach to strengthen and protect construction materials with novel calcium-oxalate-silica nanocomposite. Construction and Building Materials 62:8-17.
4. Sassoni E, Graziani G, Ridolfi G, Bignozzi M C and Franzoni E (2017) Thermal behavior of carrara marble after consolidation by ammonium phosphate, ammonium oxalate and ethyl silicate. Materials and Design 120:345–353.
5. Pondelak A, Kramar S, Kikelj M L and Škapin A S (2017) In-situ study of the consolidation of wall paintings using commercial and newly developed consolidants. Journal of Cultural Heritage 28:1-8.

Biography

Luca Panariello completed a Master's degree in Industrial Chemistry in February 2014. He obtained professional qualification as Chemist in December 2014. He received University Scholarship at the Department of Chemical and Industrial Chemical about production of polymeric thickening additives for lubricating oils in collaboration with ENI S.p.A. and University Scholarship at the Department of Civil and Chemical Engineering about antimicrobial properties of modified polymer films for packaging. Currently, he is a Granted Researcher and PhD student working on the production of nanocalcite suspension for cultural heritage application and toughening agent for plastics. His research activity focuses on Polymer Science, in particular Nanometric Composite.

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HYDROGEN TRAPPING SITES IN AISI 316L AND AISI 446 STAINLESS STEELS

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The most popular grades, thanks to their good mechanical and corrosion properties, are austenitic and ferritic stainless steel, which cover more than 95% of the global stainless steel production. They are mainly used in the oil and gas, food, chemical and construction industries. When a stainless steel is exposed to relatively high temperatures for long period of time, the precipitation of various intermetallic compounds and phases can occur. This causes the sensitization of the steel, and consequently brings about reduction of its corrosion resistance. In a same way, intergranular carbides precipitation can generate fracture susceptibility along boundaries. In general, hydrogen can have a deleterious effect on metals, since only a small amount is enough to cause serious degradation of corrosive and mechanical properties. Second phases play very important role in the hydrogen trapping behavior and have a significant effect on the possible hydrogen embrittlement mechanism. In this work several thermal treatments were carried out, considering different cooling conditions on two stainless steel grades, AISI 316L and AISI 446. Specifically, the objective of this work is to show the effects of different kinds of precipitates (such as, carbides and intermetallic phases) acting as hydrogen traps which can naturally affect the corrosion behavior of steels. Hydrogen charging was performed by the cathodic permeation method with graphite anode and constant current density of 35 mA/cm^2 for 3.5 h. A 1N H_2SO_4 electrolyte solution was used, with the addition of 0.25 g/L of $NaAsO_2$, before and after heat treatments. The microstructural characterization carried out in both steels allowed to detect a wide variety of carbides, with variable chromium contents and different morphologies. The ferrite-carbide interfaces could be identified as the main hydrogen trap sites in the AISI 446 and the grain boundaries in the AISI 316L.

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2. **Yu C, Shiue R K, Chen C and Tsay L W (2017) Effect of Low-Temperature Sensitization on Hydrogen Embrittlement of 301 Stainless Steel. Metals 7:58.**
3. **Argandoña G, Palacio J F, Berlanga C , Biezma M V, Rivero P J, Peña J and Rodríguez R (2017) Effect of the temperature in the mechanical properties of austenite, ferrite and sigma phases of duplex stainless steels using hardness, microhardness and nanoindentation techniques. Metals 7:219.**

Biography

Prof. Dr. Graciela Mansilla, born 1963, received her MSc and PhD in Physics at the National University of Rosario, Argentina. She is currently Associate Professor and Researcher at the National Technology University of San Nicolas (UTN-FRSN), Argentina. Her working area is associated with Physical Metallurgy of ferrous and non-ferrous alloys (stress relaxation, tensile and fatigue behavior, wear and hydrogen embrittlement). She has numerous publications in Congresses and Journals of scientific interest.

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Prof. Eng. Mariano Inés, born 1985, received his Metallurgical Engineer degree at the National Technology University of San Nicolas (UTN-FRSN), Argentina. He is currently professor and researcher at the UTN-FRSN, Argentina. His work area is related with hydrogen embrittlement of steels and its alloys. Currently he is working on his PhD in engineering at the Physical Metallurgy Laboratory of the UTN-FRSN.

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STUDY OF THE INFLUENCE OF VOLTAGE AND TIME ON THE MORPHOLOGY OF TIO2 NANOTUBE MATRIX USING GRAPHITE AS CATHODE AND ORGANIC ELECTROLYTE

M Luna Cervantes, A Báez Rodríguez, A M Ceballos Valle, A C García Velasco, Ma G Soriano Rosales, J Hernández Torres and **Y L Zamora Peredo**

Centro de Investigación en Micro y Nanotecnología - Universidad Veracruzana, Mexico

A 6x6 matrix of anodization experiments was planned and designed to obtain a tubular matrix of TiO_2 where we can observe and identify exactly how the morphology is influenced by voltage and time under an organic electrolyte and using graphite as cathode, even identify the time-lapse where nanograss is introducing in our nanotubular matrix. The anodization process consisted of an organic electrolyte of ethylene glycol, deionized water and NH4F, six different voltages and a time lapse from 1 to 6 hours. After the anodization, the whole set of anodized samples were rinsed with deionized (DI) water and dried under heat gun (low temperature), no samples were cleaned in ultrasonic bath because we wanted to preserve the nanograss structure if it was there. The anodized samples were annealed to obtain the crystalline anatase phase. Optical characterization was performed by Raman spectroscopy to identify the increases in signal intensity, associated with the presence of nanotubes or nanograss. The morphological characterization was performed with scanning electron microscopy to visually verify the presence and density of the nanotubes, morphological structure (radial and length dimensions) and if nanograss was in there.

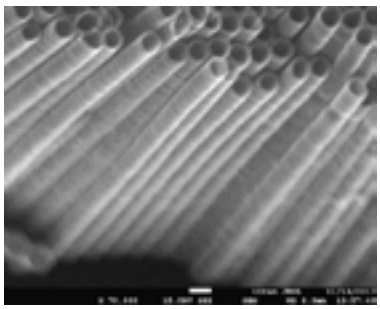

Figure 1: TiO2 nano tubes matrix.

Biography

M Luna Cervantes studying a Master Sciences in Micro and Nano Systems. Several years was dedicated to teaching fields in 3D Technology (printing, scanning and modeling) using vanguard devices. Currently the goals are focused into research and science to SERS applications and how we can use it for environment cleaning applications.

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THE EFFECT OF LASER MELTING ON THE GRAY CAST IRON SURFACE ROUGHNESS

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The surface condition of a component is usually the most important engineering factor affecting its performance. Almost inevitably the outer surface of a workpiece is subjected to wear, fatigue and corrosion while it is in service. Average roughness (Ra) is important feature of the surface. It contributes slide wear, friction, corrosion, oxidation, fatigue, physical properties (optical, electrical, and thermal properties) and esthetic. Laser as a source of high concentrated heating energy was used successfully in surface treating of ferrous material products. Laser heating or melting induces phase transformation and structural changes, also low distortion with minimal disruption. These changes affect the surface roughness either negatively or positively that is depending on the processing set of parameters. Laser processing variables comprise that related to laser source (power intensity, operation mode and wavelength) and to the material (physical properties, surface absorptivity and geometry) in addition to laser scanning speed and shrouding gas flow rate. [8]. To avoid post processing and get preferred surface roughness the relation between laser parameters and surface roughness is to be investigated for a given material. Many researchers study the effect of laser cutting and heat treating parameters on surface roughness. In this work investigation of the effect of processing variables on the average surface roughness (Ra) of gray cast iron melted by CW diode-fiber Yb:YAG laser. Power intensity (I), time of interaction (t), and gas flow rate (g) were used as variables. It is found that for power intensities that maintain melting, decreasing time of interaction, increasing shrouding gas flow rate or increasing both of them led to increased average surface roughness. Table 1 represents the processing parameters via the resulted microhardness and the average surface roughness.

Recent Publications

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2. Rehab H. Khanjar, " Analysis of gray cast iron microstructure and hardening by using Yb:YAG Laser", PhD Thesis series, University of technology/Baghdad.
3. Mohammed J. Kadhim Rehab H. Khanjar and Adil Abass Alwan. 2016. Performance evaluation of laser melting gray cast iron. , The First International Conference for Engineering Researches ICER(1-2/3/2017) Middle Technical University, Baghdad, Iraq.
4. Khayria Salman, Rehab H. Khanjar and Shada M. Rajaa, 2011. The Effect of Liquid Nitriding and Carborizing on Adhesive Wear resistance of carbon steel 1020. Engineering & Technology Journal V 29, essue 5, pp 231-240.

Sample No.	I (W/mm2)	t (s)	g (SLPM)	Ra (μm)	Hv kg/m²
1	44.45	0.66	0	1.63	280
2	62	1.32	10	1.24	811
3	81.15	0.76	20	3.13	652
4	84	0.96	5	1.2	626
5	117	0.48	20	1.83	601
6	134	0.096	10	4.99	694
7	187	0.19	0	4.45	792
8	215	0.15	20	4.46	859

Figure 1: Nano particles and their effect on yield and economics of B. juncea

Biography

Fifteen years of working research experience at National dairy Development Board, CAR C-NEH Region, Directorate of Rapeseed-Mustard Research and ICAR-Indian Agricultural Research Institute, New Delhi. Specialized in farming system research under hill and shifting cultivation for higher income, micro-irrigation and resource conservation technologies in mustard based cropping system. Handled externally funded and institute projects. Published >65 international and national research papers, ten bulletin, four extension folders, 15 book chapters and one book. Also handled 10 externally funded project including World Bank sponsored and 12 institutional projects.

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ENERGY EFFICIENT DESIGNS: CLEANER AND GREENER ENERGY TECHNOLOGIES, SUSTAINABLE DEVELOPMENT AND ENVIRONMENT

Abdeen Omer
Nottingham, UK

The move towards a de-carbonised world, driven partly by climate science and partly by the business opportunities it offers, will need the promotion of environmentally friendly alternatives, if an acceptable stabilisation level of atmospheric carbon dioxide is to be achieved. This requires the harnessing and use of natural resources that produce no air pollution or greenhouse gases and provides comfortable coexistence of human, livestock, and plants. This article presents a comprehensive review of energy sources, and the development of sustainable technologies to explore these energy sources. It also includes potential renewable energy technologies, efficient energy systems, energy savings techniques and other mitigation measures necessary to reduce climate changes. This article presents a comprehensive review of energy sources, the development of sustainable technologies to explore these energy sources. It also includes potential renewable energy technologies, energy efficiency systems, energy savings techniques and other mitigation measures necessary to reduce climate change. The article concludes with the technical status of the GSHP technologies. A geothermal heat pump can transfer heat stored in the earth into a building during the winter, and transfer heat out of the building during the summer. Furthermore, special geological conditions, such as hot springs, are not needed for successful application of geothermal heat pumps. The GSHPs are receiving increasing interest because of their potential to reduce primary energy consumption and thus reduce emission of the GHGs. The GSHP is generally recognised to be one of the most outstanding technologies of heating and cooling in both residential and commercial buildings, because it provides high coefficient of performance (COP), up to 3-4 for an indirect heating system and 3.5-5 for a direct heating system.

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CHITOSAN/GELLAN GUM/β-CYCLODEXTRIN/CURCUMIN HYDROGEL AS A SUPPORT MATRIX FOR ENHANCING ADHESION AND PROLIFERATION OF HUMAN ADIPOSE-DERIVED STEM CELLS

Alessandro F Martins[1], Ariel C de Oliveira[1], Bruno H Vilsinski[1] and **Matt J Kipper[2]**
[1]Federal University of Technology, Brazil
[2]Colorado State University, USA

Chitosan (CS) is recognized for its excellent performance to interact with polyanionic macromolecules (such as gellan gum, GG) to enable the production of physical hydrogels (polyelectrolyte complexes; PECs). CS was associated with GG, β-cyclodextrin (β-CD) and curcumin (CU) to create PECs for wound healing purpose. CS/GG/β-CD/CU hydrogels containing large contents of pores were produced by the first time, controlling the pHs of the CS solutions and CS:GG/β-CD/CU weight ratios. Stable PECs matrices were created using a suitable level of CU (23 mg) at GG/β-CD solutions in a 2/1 rate at pH 6.0. The CU could organize the polymeric chains in the hydrogel networks, allowing the formation of materials with well-defined pore structures. After neutralization step, the hydrogels loaded with CU displayed self-assembling behaviors. SEM images of the CS/GG/β-CD/CU hydrogels before and after neutralization (performed in ultrapure water) confirmed the reorganization of polymer chains. The self-assembling capacity was also confirmed by thermal analysis. Throughout the neutralization step, the CU was not released from the PEC matrix. So, the β-CD/CU complex can stabilize the PECs arrangements, permitting the development of a stable support matrix (scaffold) to enhance the adhesion and proliferation of human adipose-derived stem cells (ADSC cells). Scaffolds used for wound healing and tissue engineering purposes should similarly promote cell adhesion and provide mechanical and chemical cues that can guide cell shape, cell migration, and other relevant cellular activities. In this facet, CS/GG/β-CD/CU hydrogel significantly promotes ADSC attachment, adhesion, and proliferation. The number of adhered cells on the PEC surface significantly increased throughout seven days ($p<0.05$). Fluorescence and SEM images confirmed these statements.

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PREDICTING THE MECHANICAL BEHAVIOR OF EPOXY RESIN BASED CARBON NANOTUBES

Mohammed Al-Bahrani and **Alistair Cree**
Plymouth University, UK

This investigation has done to calculate the mechanical properties of epoxy resin reinforced with different weight fractions (0.1%, 0.2%, 0.3%, 0.4%, and 0.5%) of multiwall carbon nanotubes and two type of functionalization (MWCNTs and COOH-MWCNTs). In this work, the ultrasonic probe and ultrasonic bath were used to prepare the nanocomposites. The ANSYS workbench program version (16.2) and mathematical approach have employed to predict the nanocomposites mechanical properties. The scanning electron microscope (SEM) has used to show surface morphology of the tested nanocomposites. The results obtained using simulation approach and after compared with experimental results show that increases in MWCNTs content lead to enhance the mechanical properties of the pure epoxy resin.

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ULTRAFAST DEMAGNETIZATION DYNAMICS BY TIME RESOLVED XMCD

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Ultrafast processes involving the electrons and spins are important issues for both fundamental science and for the potential applications in spintronics. Application of ultrashort infra-red laser pulses allows ultimately the manipulation of the local magnetization in magnetic films. In order to understand the change of the initial magnetic or structural state, induced by IR laser pulses, it is essential to describe the individual and fundamental processes taking place during the first hundred femtoseconds. Since the first observation of laser induced spin dynamics, the mechanisms responsible for the femtosecond demagnetization have been widely debated, but no consensus could be found until today. Time-resolved x-ray magnetic circular dichroism (XMCD) using synchrotron facilities and x-ray free electron sources have provided femtosecond time resolution and thus new information concerning femtosecond demagnetization dynamics. XMCD spectroscopy is an element-specific tool which can be used to study ultrafast magnetization, with chemical resolution. At soft x-ray energies it is now possible to measure the dynamics of the spin and orbital magnetic moments with temporal resolution of ~100 fs. Recent results using the potential of the XMCD technic, show that right after the IR laser excitation, interatomic transfer of angular moment takes place at the femtosecond scale, whereas the global demagnetization proceeds, illustrating one of the most efficient way of conservation of angular moment, during the loss of magnetization in the system. In recent works, it was shown that laser induced electron current activates sizable ultrafast dynamics too. Different theoretical approaches propose different microscopic models which are nowadays strongly debated. Our recent results show that such hot-electron current induced ultrafast dynamics produces two different characteristic times of demagnetization in rare earth 4f as well as in transition metal 3d elements in 4f-3d alloys. The results can be related to propagation times and velocities of the hot-electron pulses.

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FABRICATION OF COMPOSITE BIO-SCAFFOLDS BY USING 3D PRINTED PLA AND ELECTROSPUN PCL NANOFIBERS

Hae Woon Choi, Jae Hoon Choi, Ji Soo Kim and **Min Ji Sohn**
Keimyung University, South Korea

This paper introduces a novel approach to fabricate bio-scaffolds by using composite materials of 3D printed PLA and electro-spun PCL nanofibers. Polycaprolactone (PCL) is biodegradable polyester with a low melting point and it is one of the most common biodegradable materials in long-term implants and controlled drug release applications. Polylactic acid (PLA) is another biodegradable polymer in use for medical applications. PLA is a biodegradable and bioactive thermoplastic derived from renewable resources such as corn starch or sugarcane. PLA has five times higher tensile strength than PCL which provides better mechanical stability for the bio-scaffold applications. By combining the excellent bio-solvability of PCL and good mechanical stability of PLA, a novel composite bio-scaffold was fabricated. For the higher cell adhesion or growth, PCL was formed as nanofibers by electro spinning technology while PLA was formed as a meshed matrix for higher mechanical strength. The PCL fibers fabricated by electrospinning technology ranged between 100s of nanometers and 10s of micrometers depending on concentration of solvents, applied voltage, flow rate and etc. The PLA mesh was fabricated by a state of the art fused deposition modeling (FDM) type 3D printer with 0.2 mm thickness. In results, the fabricated bio-scaffolds showed higher strength compared to a single PCL material and higher cell adhesion environment.

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CONTAINERLESS UNDERCOOLING AND SOLIDIFICATION OF METALS AND ALLOYS

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An undercooled melt possesses an enhanced free enthalpy that gives access to crystallize metastable solids. Crystal nucleation selects the crystallographic phase whereas the subsequent crystal growth controls the microstructure evolution. Electromagnetic and electrostatic levitation techniques are very efficient to produce a highly undercooled melt since heterogeneous nucleation on container-walls is avoided. Moreover, a freely suspended drop is accessible for in situ observation of crystallization far away from equilibrium. We combine levitation technique with the diagnostic means of neutron scattering to investigate short range order in undercooled melts and energy dispersive x-ray diffraction of synchrotron radiation to observe phase selection processes upon undercooling. Measurements of the statistics of nucleation undercooling are performed in order to study the physical nature of crystal nucleation. Nucleation is followed by crystal growth. In undercooled melts the crystal grows with dendritic morphology since a planar interface is destabilized by the negative temperature gradient ahead the solid liquid interface. In highly undercooled melts dendrites propagate very rapidly. A high speed camera is used to record the advancement of the solidification front. Dendrite growth velocities are measured as a function of undercooling of pure metals, solid solutions and intermetallics. Non-equilibrium crystallization effects are evidenced. Crystal growth is governed by heat and mass transport. To explore the influence of convection on dendrite growth comparative experiments in microgravity are performed using an electromagnetic levitator on board the International Space Station. Metals show dendritic growth in a mesoscopic scale with a rough interface at the microscopic scale. In case of semiconductor, the solidification front is facetted in a mesoscopic scale with a smooth interface in a microscopic scale. The entropy of fusion of the compound Ni2B is located in between that of metals and semiconductors. A transition from dendritic to facetted growth is observed induced by convection in the undercooled drops.

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EFFECTIVENESS IN UV ABSORPTION OF HIERARCHICAL NANO ZNO-MICROTIO$_2$ COMPOSITES WITH PHOTODEGRADATION INHIBITION

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Nowadays, sunscreens are formulated by using TiO_2 and ZnO nanoparticles because they are efficient inorganic UV filters. In fact micro sized TiO_2 and ZnO have been increasingly replaced by TiO_2 and ZnO nanoparticles in order to solve the cosmetic drawback of the white opaque sunscreens apart from the higher yield that nanoparticles suppose. Also the aggregation state of the particles in sunscreens is related to the solar protection factor (SPF) of the final emulsion. In this sense, dispersed nanoparticles into sunscreens increase the SPF value, but it means a possible leading to their incorporation into the stratum cornea, the outer layer of the skin. Moreover, when TiO_2 is irradiated produces free radicals which are implicated in a number of potential health issues such as skin aging because of the formation of reactive oxygen species (ROS). In this work, composites combining TiO_2 micro particles and ZnO nanoparticles have been achieved by using several synthesis and dispersion methods. It has been demonstrated by the incorporation of the different composites into sunscreens that the presence of nanoparticles anchored over TiO_2 micro particles allows increasing the efficiency of nanoparticles but decreases the possible health problems by their absorption as nanoparticles. The aim of these new composites is to gain the advantages of inorganic nanoparticles avoiding their potential drawbacks. Hence, the combination of both oxides provokes higher SPF value and lower photodegradation, in comparison with TiO_2 micro particles. Moreover, the disposition of ZnO and TiO_2 particles means a positive synergy by the recombination of photo induced electrons holes, which decreases the formation of free radicals.

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NANOMATERIAL AND NANOSTRUCTURES FOR ENERGY CONTROL AND ENERGY HARVESTING

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Among other features, smart phones and other new electronic objects for internet of things require low consumption and sensing devices, while larger autonomy is a need from the user side. While photovoltaic devices are limited to appropriate outdoor conditions, nanobased thermoelectric and piezoelectric energy harvesters can operate continuously. Efforts are made to increase the figure of merit ZT of thermoelectric devices together with using environmental safe materials. We present such an alternative, nanocomposite superlattices with SiGe, Ti and Mg silicides materials. Such artificial materials are engineered to enhance their thermoelectric properties when appropriate crystal structure, dimensions and doping levels are chosen. Another strategy to harvest energy, also taking advantage of the specific nanoscale properties, is the realization of ZnO and GaN nanogenerators. Modeling and electromechanical characterization are realized at the nano and macro scales. Appropriate engineering of the nanogenerators can lead to large performances. Nanoswitches can be used to control energy of part of the IC circuit. Nanostructured devices are also presented for low energy sensing application. Several prototypes and applications are shown to demonstrate their potential for future applications.

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STRUCTURE INVESTIGATION OF NANOCOMPOSITES CONTAINING GRAPHENE

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Graphene, which is a unique two-dimensional carbon nanostructure, has low density, high specific surface area. It has inspired enormous interests because of its outstanding mechanical, thermal and electrical properties. Due to its extraordinary mechanical, chemical, thermal and electronic properties, graphene possess the wide range of possible uses as biosensors, electronic devices, energy conversion and storage, solar cell. A very important field of graphene applications is polymer composites. Graphene nanoplatelets are one of the most widely used forms of graphene; consist of stacks of several graphene monolayers with thickness of up to approximately 10 nm. Fortunately, compared to monolayer graphene, graphene nanoplatelets were mass production with low cost, and also have excellent mechanical and electrical properties. During recent years, a number of groups have explored the fabrication of nanocomposites reinforced with graphene nanoplatelets. Modification of polymers with graphene may eventually lead to production of new composites with properties similar to those of pure graphene i.e. materials with improved electrical, thermal, mechanical or with greater capacity to absorb electromagnetic waves. In this paper will be shown results from research on attempts to modify polyester (PET) with graphene. This will be presented in both laboratory fibers formation tests and technological attempts at industrial conditions. For the obtained fibers results of thermal (DSC, TGA), mechanical, structural and spectroscopic method will be shown. The proposed method is simple and inexpensive way of obtaining a thermoplastic polymer nanocomposites containing graphene.

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THE SINGLE PHASE CONSTITUTIVE RELATION OF DUAL PHASE STEEL BASED ON NANOINDENTATION TEST AND FINITE ELEMENT MODELING

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Dual phase steel is widely used in manufacturing for its excellent combination of strength with plasticity. Previously, much attention has been paid in the strengthening mechanism of dual phase steel and a great deal of papers have been published while the plastic deformation mechanism has not been further discussed. In this paper, combining the nanoindentation test with finite element modeling the single phase constitutive equations of dual phase steel was established. To solve the P-h curve, reverse analysis algorithms and five dimensionless function are adopted. In addition, the nanoindentation is simulated by ABAQUS to validate the accuracy of numerical calculation. A representative stress and corresponding representative strain are solved by dimensionless functions and updated with finite element modeling. Forty nanoindentation sites are tested and simulated to investigate the impact of friction and tip shape of indenter in modeling. Finally, we will give a complete method of solving constitutive relation from nanoindentation and provide a theoretical basis for the further study of dual phase steel's plastic behavior. The constitutive relation of ferrite and martensite are completed, which reveals the average yield stress and strain hardening index of martensite and ferrite are 830.06MPa, 0.182, 360.34MPa, 0.226 respectively. For complete martensite steel, the yield stress and strain hardening index are 1352.85MPa and 0.130. The uniaxial tensile results are 416.81MPa and 0.2.

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MAGNETOPLASMONIC NANODOMES AS A NOVEL STRUCTURE FOR BIOMEDICAL APPLICATIONS

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Advanced nanobiomedical applications have been traditionally based on chemically synthesized, bottom-up, multifunctional core/shell or Janus-type inorganic nanoparticles. Here we present a novel type of structure especially suited for diverse biomedical uses: magnetoplasmonic nanodomes. The nanodomes are composed of a combined magnetic and plasmonic hemispherical shell deposited onto 100 nm diameter polystyrene beads. The variation of the materials and their thicknesses in the shell enables tuning both the optical and magnetic properties of the nanostructures. For example, Fe magnetic layers lead to in-plane magnetization, while [Co/Au] multilayers result in structures with out-of-plane magnetic anisotropy. Using Au plasmonic layers allows adjusting the plasmonic resonance to be in the near infrared, where the penetration in tissues is maximized. The very high plasmonic absorption of the nanodomes is used for very efficient local optical heating, i.e., photo-hyperthermia for cancer treatment. The magnetic character of the nanodomes allows to remotely manipulate them and thus to easily regulate the level of photo-hyperthermia. Moreover, given their asymmetric shape the nanodomes exhibit a strong optical anisotropy, where the plasmonic resonances parallel and perpendicular to the nanodomes take place at different wave lengths. Moreover, since the nanodomes have magnetic anisotropies, when using alternating magnetic fields they can rotate inside liquids. This rotation can be easily tracked optically using the different absorption of the nanodomes depending on their orientation with respect to the light polarization. Since the rotation of the nanoparticles depends strongly on the viscosity of the medium, which in turn depends on the temperature, the optical tracking of the rotation can be used to accurately determine the local temperature around the nanodomes, i.e., nanothermometry. Thus, combining the nanodomes efficient photo-hyperthermia with their nanothermometry capabilities, allows in-situ tracking the efficiency of photo-hyperthermia treatments.

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EFFECT OF MILLING ON THE STRUCTURAL, MAGNETIC AND CATALYTIC PROPERTIES OF ZINC FERRITE SYNTHESIZED BY MICROWAVE COMBUSTION METHOD

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Zinc ferrite nano-crystals were successfully synthesized from its stoichiometric metal nitrates and glycine mixtures, using a microwave assisted combustion method. The as prepared sample was subjected to high energy ball milling for different periods of time. Structural and magnetic properties have been investigated by XRD, FTIR, VSM and Mössbauer spectroscopy. Results revealed that the as-prepared sample is a monophase zinc ferrite possesses high crystallinity. A minor of α-Fe_2O_3 phase is detected after milling. The average crystallite size of the as prepared (AP) $ZnFe_2O_4$ powder is about 27 nm. This value decreased with milling time reach to around 9 nm after 330 min. FTIR spectra showed two absorption bands in the zinc ferrite structure related to octahedral and tetrahedral sites in the range of 400-600 cm^{-1}. The room temperature Mössbauer spectra of the samples are representing the coexistence of both ferrimagnetic ordering and superparamagnetic phases. The magnetic measurement at room temperature confirmed the ferrimagnetic behavior of the samples. The saturation magnetization value of the as prepared $ZnFe_2O_4$ is 47 emu/g was observed and its value decreased to 29 emu/g after 330 min of mill. The catalytic activity for the as prepared and milled samples was carried out using dehydrogenation – dehydration of isopropyl alcohol. The results revealed that the samples are active and highly selective towards the formation of acetone and propene.

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DESIGN AND DEVELOP HIGH PERFORMANCE LIFEPO4/C NANOCOMPOSITES AS CATHODE MATERIALS FOR RECHARGEABLE LITHIUM ION BATTERIES BY CATION EXCHANGE PROCESS

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Nanomaterials, so often reported by claims of delivering multifarious properties, have the genuine potential to make a significant impact on the performance of advanced energy storage and conversion devices (e.g. batteries, super capacitors, fuel cells and solar cells), especially in the high-power aspect, as the reduced dimensions enable far more accessible active surfaces as well as enhanced diffusion dynamics. Herein, we present our detailed work on a novel lithiation of amorphous hydrated $FePO_4$, typically $FePO_4$-PANI (polyaniline) composite, by a facile H^+/Li^+ ion exchange that was attentively deduced and studied with the help of several relevant chemical/physical analytical techniques. The resultant Li-derivative is proved to be a suitable precursor for yielding $LiFePO_4$/C nanocomposite with ideal structural features containing highly crystalline $LiFePO_4$ nanoparticles completely coated with N-doped conductive carbon. More importantly, the $LiFePO_4$/C nanocomposite is capable of offering outstanding electrochemical performances for lithium-ion batteries in terms of high rate capability (~80.3 mAh g-1 at 100) and long-term cyclability (less than 3% discharge capacity loss over 600 cycles at 10) that were strongly supported by the results of cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) tests.

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DEVELOPMENT AND DEMONSTRATION OF HIGHLY INSULATING, CONSTRUCTION MATERIALS FROM BIO-DERIVED AGGREGATES

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The ISOBIO project will develop a new approach to insulating materials through the novel combination of existing bio-derived aggregates with low embodied carbon and with innovative binders to produce durable composite construction materials. These novel composites will target 50% lower embodied energy and CO_2 at component level and 20% better insulation properties than conventional material. The project will also seek to demonstrate a reduction of at least 15% in total costs and 5% total energy spent over the lifetime of a building. ISOBIO started by identifying promising organic materials that could be used as insulation. Many of these are classified as waste or by-products of processes like food production. Finely chopped bio-materials such as hemp and straw are treated with hygrothermal resins and nano- particles that make them robust, breathable, moisture resistant, and fire retardant. The bio-aggregates are typically the result of combining organic and inorganic materials; the organic material may have natural insulating properties, for example, while the inorganic material may make the resulting bio-aggregate more robust. Combing organic materials with inorganic materials is not always easy, however. Hemp, for instance, is being combined with lime mortar but the two materials have a degree of chemical incompatibility which could result in a reduction in the strength of the composite material. To overcome this challenge, ISOBIO's researchers are using nano-technology to increase the interfacial strength between the two materials, giving the resulting composite material improved mechanical and structural properties. The new materials not only improve upon the performance of conventional materials, they also offer new features. Hemp shiv, which is the core of the hemp stalk, for example, has a porous structure that provides moisture buffering to maintain humidity at a more constant level. While the new composite materials may provide more comfort, they need to be at least as robust as conventional materials. To make the hemp-based bio-aggregate water repellent, for example, ISOBIO's researchers are applying hydrophobic treatments to it. The result is that water vapor can travel in and out of the material but liquid water cannot penetrate it. TWI is exploring the development of novel inorganic-organic hybrid nano-materials, to be applied as a surface treatment onto bio-based aggregates. These nanoparticles are synthesized by sol-gel processing and then functionalized with silanes to impart multifunctionality e.g. hydrophobicity, fire resistance and chemical bonding between the silica nanoparticles and the bio-based aggregates. This talk will illustrate the approach taken by TWI to design the functionalized silica nanoparticles by using a material-by-design approach. The formulation and synthesize process will be presented together with the challenges addressed by those hybrid nano-materials. The results obtained with regards to the water repellence and fire resistance will be displayed together with preliminary public results of the ISOBIO project.

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DESIGN OF 3D BIOPRINTED SCAFFOLDS FOR CARTILAGE REGENERATION

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Cartilage is a dense connective tissue with limited self-repair properties. Currently, the therapeutic use of autologous or allogeneic chondrocytes makes up an alternative therapy to the pharmacological treatment. The design of a bioprinted 3D cartilage with chondrocytes and biodegradable biomaterials offers a new therapeutic alternative able of bridging the limitations of current therapies in the field. We have developed an enhanced printing processes-injection volume filling (IVF) to increase the viability and survival of the cells when working with high temperature thermoplastics without the limitation of the scaffold geometry in contact with cells. We have demonstrated the viability of the printing process using chondrocytes for cartilage regeneration. An alginate-based hydrogel combined with human chondrocytes (isolated from osteoarthritis patients) was formulated as bioink-A and the polylactic acid as bioink-B. The bioprinting process was carried out with the REGEMAT V1 bioprinter (Regemat 3D, Granada-Spain) through an IVF. The printing capacity of the bioprinting plus the viability and cell proliferation of bioprinted chondrocytes was evaluated after five weeks by confocal microscopy and alamarBlue assay (Biorad). Results showed that the IVF process does not decrease the cell viability of the chondrocytes during the printing process as the cells do not have contact with the thermoplastic at elevated temperatures. The viability and cellular proliferation of the bioprinted artificial 3D cartilage increased after five weeks. In conclusion, this study demonstrates the potential use of Regemat V1 for 3D bioprinting of cartilage and the viability of bioprinted chondrocytes in the scaffolds for application in regenerative medicine.

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SPECIFIC SURFACE AREA FROM NITROGEN ADSORPTION DATA AT 77 K USING THE ZETA ADSORPTION ISOTHERM

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The determination of the specific surface area (SSA) of solid powders has been a long standing problem in surface science. We use the zeta adsorption isotherm (ZAI) and propose a method for determining the SSA of powders using the N_2 adsorption measurements at 77K. The consistency of the results obtained is demonstrated using two α-alumina samples that have different total surface areas. When the proposed method is applied to convert the amount adsorbed per unit mass to the amount adsorbed per unit area, we show that there is no measurable difference between their adsorption isotherms. Also, we show the proposed method can be applied to six different powders having a variation in their specific surface areas of two orders of magnitude. The corresponding error can be obtained from a single equilibrium adsorption measurement and maximum standard deviation in the mean value of the SSA among six cases is less than 7%.

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RAPID OPTICALLY DIRECTED ASSEMBLY OF NANO-PATTERNED METASURFACES WITH COLLOIDAL NANOPARTICLES

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Plasmonic metasurfaces are emerging as two-dimensional metamaterials capable of manipulating the phase, amplitude, and polarization of light on the nanoscale, which have been successfully demonstrated as abundant promising applications in advanced photonic devices. Plasmonic nano-patterned colloidal metasurfaces enable light manipulation at the nanoscale. However, a fast and controllable fabrication for such structures remains a major challenge in nano-optics. Here, we propose a strategy for rapid optically directed assembly (ODA) of colloidal metallic metasurfaces with ordered nano-patterns using orthogonal laser standing evanescent wave (LSEW) fields within less than 10 minutes. We demonstrate the underlying cooperative mechanism of optical forces exertions on colloidal nanoparticles (NPs) in orthogonal LSEW fields with a non-focused ultralow fluence irradiation of 0.25 Wcm-2, which leads to the formation of nano-patterned colloidal silver metasurfaces with a large area of 50 mm2. The demonstration of polarizations stabilizing during the nano-patterns formation confirmed by a polarization-dependent surface enhanced Raman spectroscopy (p-SERS) characterization substantiates further the interpretation of dynamical driving and binding processes of ODA. This unique combination of top-down nanostructured optical fields directing and bottom-up assembly provide an important foundation for designing and fabricating reconfigurable colloidal nano-patterned metasurfaces for nanoscale control of optical fields. This study constitutes the fundamental step for the fabrication of complex functional nanostructures based on the assembled NPs, which provides the capabilities and applications of optical trapping in new and intriguing ways and offers the perspectives on the rapidly emerging areas of nano-photonics and nano-biology.

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HAIRY NANOPARTICLES AS BUILDING BLOCKS FOR NANOPOROUS MEMBRANES

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Nanoporous membranes attract increasing attention due to their applications in molecular separations, biosensing, drug-delivery and catalysis. Many of these applications require control over the nanopore size with a narrow size distribution and the ability to further modify the membrane surface. Most currently used membranes are formed by introducing pores into bulk materials in a variety of irreversible processes. Membranes formed from nanoparticles using non-covalent interactions, on the other hand, are capable of reversible assembly which could prove useful for fabrication, processing, cleaning, reusing and would possess facile control over the membrane porosity and nanopore surface properties. This talk will describe the preparation and characterization of durable, reversible nanoporous ultrafiltration membranes with controlled thickness, area and pore size by self-assembly of silica nanoparticles grafted with polymer brushes (hairy nanoparticles, HNPs). The nanoparticles used to form the membranes were prepared by first modifying their surface with 2- bromoisobutyryl bromide (ATRP initiator). The pSPM-r-pEEMA, pDMAEMA-r-pMMA, pSPM, pHEMA, pHEMA-r-pSPM and pSPM-r-pEEMA brushes were grown on the surface of silica spheres using ATRP. We prepared three types of HNP membranes: membranes made of HNPs grafted with polymer brushes carrying acidic and basic groups, membranes in which the grafted polymer brushes have neutral groups, and membranes grafted with negatively charged polymer brushes. Depending on the HNP building block type the membranes are stable in most organic solvents and easily disassemble in water, or water-stable and capable of disassembly in organic solvents. All types of membranes are nanoporous and capable of size-selective transport and ultrafiltration. We will also describe the formation of nanoporous membranes from HNPs grafted with copolymer brushes carrying functional groups in the side chain, and combining reversibility with ultrafiltration, charge selectivity and affinity properties.

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