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1. Nanoscience and Nanotechnology

Led by Nanoscale Research Letters, Nano-Micro Letters, and Micro and Nano Systems Letters, our nano science journals offer homes for a wide range of nano science research and results. Ranging from the advanced imaging technologies and techniques underpinning nano science to nano biology, nano materials, and more, our journals include journals published with international partners as well as broad, comprehensive nano journals.

Nanoscale Research Letters

Nanoscale Research Letters (NRL) provides an interdisciplinary forum for communication of scientific and technological advances in the creation and use of objects at the nanometer scale. NRL is the first nanotechnology journal from a major publisher to be published with Open Access.

Nano Express: Dilute Magnetic Semiconductor and Half-Metal Behaviors in 3d Transition-Metal Doped Black and Blue Phosphorenes: A First-Principles Study

Weiyang Yu, Zhili Zhu, Chun-Yao Niu, Chong Li, Jun-Hyung Cho, and Yu Jia

https://goo.gl/e3BHza

Abstract: We present first-principles density-functional calculations for the structural, electronic, and magnetic properties of substitutional 3d transition metal (TM) impurities in two-dimensional black and blue phosphorenes. We find that the magnetic properties of such substitutional impurities can be understood in terms of a simple model based on the Hund’s rule. The TM-doped black phosphorenes with Ti, V, Cr, Mn, Fe, and Ni impurities show dilute magnetic semiconductor (DMS) properties while those with Sc and Co impurities show nonmagnetic properties. On the other hand, the TM-doped blue phosphorenes with V, Cr, Mn, and Fe impurities show DMS properties, with Ni impurity showing half-metal properties, whereas Sc- and Co-doped systems show nonmagnetic properties. We identify two different regimes depending on the occupation of the hybridized electronic states of TM and phosphorous atoms: (i) bonding states are completely empty or filled for Sc- and Co-doped black and blue phosphorenes, leading to nonmagnetic; (ii) non-bonding d states are partially occupied for Ti-, V-, Cr-, Mn-, Fe- and Ni-doped black and blue phosphorenes, giving rise to large and localized spin moments. These results provide a new route for the potential applications of dilute magnetic semiconductor and half-metal in spintronic devices by employing black and blue phosphorenes.
Nano Express: Synthesis, Characterization, and Microwave Absorption Properties of Reduced Graphene Oxide/Strontium Ferrite/Polyaniline Nanocomposites
Juhua Luo, Pan Shen, Wei Yao, Cuifeng Jiang, and Jianguang Xu

https://goo.gl/y3k3W6

Abstract: Strontium ferrite nanoparticles were prepared by a coprecipitation method, and reduced graphene oxide/strontium ferrite/polyaniline (R-GO/SF/PANI) ternary nanocomposites were prepared by in situ polymerization method. The morphology, structure, and magnetic properties of the ternary nanocomposites were investigated by X-ray powder diffraction (XRD), Fourier transform infrared spectroscopy (FT-IR), TEM, Raman, and VSM. The microwave-absorbing properties of the composites were measured by a vector network analyzer. The XRD patterns show the single phase of strontium hexaferrite without other intermediate phases. TEM photographs reveal that strontium ferrite nanoparticles are uniformly dispersed on the surfaces of R-GO sheets. The R-GO/SF/PANI nanocomposite exhibited the best absorption property with the optimum matching thickness of 1.5 mm in the frequency of 2–18 GHz. The value of the maximum RL was −45.00 dB at 16.08 GHz with the 5.48-GHz bandwidth. The excellent absorption properties of R-GO/SF/PANI nanocomposites indicated their great potential as microwave-absorbing materials.

S. Ivanov, A. Barylyak, K. Besaha, A. Bund, Y. Bobitski, R. Wojnarowska-Nowak, I. Yaremchuk, and M. Kus-Liśkiewicz

https://goo.gl/YWH49p

Abstract: One-step TiO₂ nanoparticle synthesis based on the interaction between thiourea and metatitanic acid is applied for sulfur and carbon anatase codoping. The synthesis of the doped TiO₂ has been monitored by means of differential thermal analysis and thermogravimetric analysis (DTA-TG), which allows determining the optimal thermal conditions for the process. Electron microscopy showed micrometer-sized (5–15 μm) randomly distributed crystal aggregates, consisting of many 15–40-nm TiO₂ nanoparticles. The obtained phase composition and chemical states of the doping elements are analyzed by means of X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), infrared (IR) and Raman spectroscopies, and electron paramagnetic resonance (EPR). XRD displays in both samples (doped and pristine) the existence of only one crystalline phase—the tetragonal modification of TiO₂—anatase. Further data assessment by means of Rietveld refinement allowed detection of a slight c lattice parameter and volume increase related to incorporation of the doping elements. XPS demonstrated the presence of carbon and sulfur as doping elements in the material. It was confirmed that carbon is in elemental form and also present in oxygen-containing compounds, which are adsorbed on the particle surface. The binding energy for sulfur electron core shell corresponds to the established data for sulfate compounds, where sulfur is in 6+ oxidation state. The synthesized S- and C-codoped TiO₂ showed excellent photocatalytic performance during the degradation of organic dyes (rhodamine B, methylene blue), gas-phase oxidation of ethanol under visible light, and photocatalytic hydrogen generation from ethanol under ultraviolet light.
Nano Convergence

Nano Convergence is a peer reviewed, international and interdisciplinary research journal that focuses on all aspects of nano science and nanotechnology.

Rice husk-originating silicon–graphite composites for advanced lithium ion battery anodes

Hye Jin Kim, Jin Hyeok Choi, and Jang Wook Choi

https://goo.gl/TZyrha

Abstract: Rice husk is produced in a massive amount worldwide as a byproduct of rice cultivation. Rice husk contains approximately 20 wt% of mesoporous SiO2. We produce mesoporous silicon (Si) by reducing the rice husk-originating SiO2 using a magnesio-milling process. Taking advantage of meso-porosity and large available quantity, we apply rice husk-originating Si to lithium ion battery anodes in a composite form with commercial graphite. By varying the mass ratio between these two components, trade-off relation between specific capacity and cycle life was observed. A controllable pre-lithiation scheme was adopted to increase the initial Coulombic efficiency and energy density. The series of electrochemical results suggest that rice husk-originating Si–graphite composites are promising candidates for high capacity lithium ion battery anodes, with the prominent advantages in battery performance and scalability.

Review: Recent advances in unveiling active sites in molybdenum sulfide-based electrocatalysts for the hydrogen evolution reaction

Bora Seo and Sang Hoon Joo

https://goo.gl/otMoZZ

Abstract: Hydrogen has received significant attention as a promising future energy carrier due to its high energy density and environmentally friendly nature. In particular, the electrocatalytic generation of hydrogen fuel is highly desirable to replace current fossil fuel-dependent hydrogen production methods. However, to achieve widespread implementation of electrocatalytic hydrogen production technology, the development of highly active and durable electrocatalysts based on Earth-abundant elements is of prime importance. In this context, nanostructured molybdenum sulfides (MoS x ) have received a great deal of attention as promising alternatives to precious metal-based catalysts. In this focus review, we summarize recent efforts towards identification of the active sites in MoS x-based electrocatalysts for the hydrogen evolution reaction (HER). We also discuss recent synthetic strategies for the engineering of catalyst structures to achieve high active site densities. Finally, we suggest ongoing and future research challenges in the design of advanced MoS x-based HER electrocatalysts.

Review: Colloidal quantum dot based solar cells: from materials to devices

Jung Hoon Song and Sohee Jeong

https://goo.gl/p37U2P

Abstract: Colloidal quantum dots (CQDs) have attracted attention as a next-generation of photovoltaics (PVs) capable of a tunable band gap and low-cost solution process. Understanding and controlling the surface of CQDs lead to the significant development in the performance of CQD PVs. Here we review recent progress in the realization of low-cost, efficient lead chalcogenide CQD PVs based on the surface investigation of CQDs. We focus on improving the electrical properties and air stability of the CQD achieved by material approaches and growing the power conversion efficiency (PCE) of the CQD PV obtained by
structural approaches. Finally, we summarize the manners to improve the PCE of CQD PVs through optical design. The various issues mentioned in this review may provide insight into the commercialization of CQD PVs in the near future.

**Advanced Structural and Chemical Imaging**

There is an increasing need in many fields to deliver high-quality images and analyses using multiple imaging tools, forefront data handling, and mathematical methods for processing and simulations. With this in mind, *Advanced Structural and Chemical Imaging (ASCI)* provides a dedicated, interdisciplinary platform for knowledge sharing among scientists using such imaging and analysis techniques.

**Review: Prospects for atomic resolution in-line holography for a 3D determination of atomic structures from single projections**

*F.-R. Chen, C. Kisielowski, and D. Van Dyck*

https://goo.gl/kqV8i8

**Abstract:** It is now established that the 3D structure of homogeneous nanocrystals can be recovered from in-line hologram of single projections. The method builds on a quantitative contrast interpretation of electron exit wave functions. Since simulated exit wave functions of single and bilayers of graphene reveal the atomic structure of carbon-based materials with sufficient resolution, we explore theoretically how the approach can be expanded beyond periodic carbon-based materials to include non-periodic molecular structures. We show here theoretically that the 3D atomic structure of randomly oriented oleic acid molecules can be recovered from a single projection.

**Methodology: An environmental transfer hub for multimodal atom probe tomography**

*Daniel E. Perea, Stephan S. A. Gerstl, Jackson Chin, Blake Hirschi, and James E. Evans*

https://goo.gl/RWTcbi

**Abstract:** Environmental control during transfer between instruments is required for samples sensitive to air or thermal exposure to prevent morphological or chemical changes prior to analysis. Atom probe tomography is a rapidly expanding technique for three-dimensional structural and chemical analysis, but commercial instruments remain limited to loading specimens under ambient conditions. In this study, we describe a multifunctional environmental transfer hub allowing controlled cryogenic or room-temperature transfer of specimens under atmospheric or vacuum pressure conditions between an atom probe and other instruments or reaction chambers. The utility of the environmental transfer hub is demonstrated through the acquisition of previously unavailable mass spectral analysis of an intact organic molecule made possible via controlled cryogenic transfer into the atom probe using the hub. The ability to prepare and transfer specimens in precise environments promises a means to access new science across many disciplines from untainted samples and allow downstream time-resolved *in situ* atom probe studies.
Nano-Micro Letters

Nano-Micro Letters is a peer-reviewed, international, interdisciplinary and open-access journal published under the SpringerOpen brand that focus on science, experiments, engineering, technologies and applications of nano- or microscale structure and system in physics, chemistry, biology, material science, pharmacy and their expanding interfaces with at least one dimension ranging from a few sub-nanometers to a few hundreds of micrometers. Especially, emphasize the bottom-up approach in the length scale from nano to micro since the key for nanotechnology to reach industrial applications is to assemble, to modify, and to control nanostructure in micro scale. The aim is to provide a publishing platform crossing the boundaries, from nano to micro, and from science to technologies.

A Review on Graphene-Based Gas/Vapor Sensors with Unique Properties and Potential Applications
Tao Wang, Da Huang, Zhi Yang, Shusheng Xu, Guili He, Xiaolin Li, Nantao Hu, Guilin Yin, Dannong He, Liying Zhang
https://goo.gl/inYyB5

Abstract: Graphene-based gas/vapor sensors have attracted much attention in recent years due to their variety of structures, unique sensing performances, room-temperature working conditions, and tremendous application prospects, etc. Herein, we summarize recent advantages in graphene preparation, sensor construction, and sensing properties of various graphene-based gas/vapor sensors, such as NH₃, NO₂, H₂, CO, SO₂, H₂S, as well as vapor of volatile organic compounds. The detection mechanisms pertaining to various gases are also discussed. In conclusion part, some existing problems which may hinder the sensor applications are presented. Several possible methods to solve these problems are proposed, for example, conceived solutions, hybrid nanostructures, multiple sensor arrays, and new recognition algorithm.

Recent Advances in Visible-Light-Driven Photoelectrochemical Water Splitting: Catalyst Nanostructures and Reaction Systems
Xiaoping Chen, Zhixiang Zhang, Lina Chi, Aathira Krishnadas, Wenfeng Shangguan, Zheng Jiang
https://goo.gl/mdf7vQ

Abstract: Photoelectrochemical (PEC) water splitting using solar energy has attracted great attention for generation of renewable hydrogen with less carbon footprint, while there are enormous challenges that still remain for improving solar energy water splitting efficiency, due to limited light harvesting, energy loss associated to fast recombination of photogenerated charge carriers, as well as electrode degradation. This overview focuses on the recent development about catalyst nanomaterials and nanostructures in different PEC water splitting systems. As photoanode, Au nanoparticle-decorated TiO₂ nanowire electrodes exhibited enhanced photoactivity in both the UV and the visible regions due to surface plasmon resonance of Au and showed the largest photocurrent generation of up to 710 nm. Pt/Cds/CGSe electrodes were developed as photocathode. With the role of p–n heterojunction, the photoelectrode showed high stability and evolved hydrogen continuously for more than 10 days. Further, in the Z-scheme system (Bi₂S₃/TNA as photoanode and Pt/SiPVC as photocathode at the same time), a self-bias (open-circuit voltage $V_{oc} = 0.766$ V) was formed between two photoelectrodes, which could facilitate photogenerated charge transfers and enhance the photoelectrochemical performance, and which might provide new hints for PEC water splitting. Meanwhile, the existing problems and prospective solutions have also been reviewed.
**Novel Hybrid Nanoparticles of Vanadium Nitride/Porous Carbon as an Anode Material for Symmetrical Supercapacitor**

Yunlong Yang, Kuiwen Shen, Ying Liu, Yongtao Tan, Xiaoning Zhao, Jiayu Wu, Xiaoqin Niu, Fen Ran

https://goo.gl/QqrUCE

**Abstract:** Hybrid materials of vanadium nitride and porous carbon nanoparticles (VN/PCNPs) were fabricated by a facile pyrolysis process of vanadium pentoxide (V2O5) xerogel and melamine at relatively low temperature of 800 °C for supercapacitor application. The effects of the feed ratio of V2O5 to melamine \( r \), and nitrogen flow rate on the microstructure and electrochemical performance were also investigated. It was found that the size of the as-synthesized nanoparticles is about 20 nm. Both \( r \) value and \( N_2 \) flow rate have enormous impacts on morphology and microstructure of the nanoparticle, which correspondingly determined the electrochemical performance of the material. The VN/C hybrid nanoparticles exhibited high capacitive properties, and a maximum specific capacitance of 255.0 F g\(^{-1}\) was achieved at a current density of 1.0 A g\(^{-1}\) in 2 M KOH aqueous electrolyte and the potential range from 0 to −1.15 V. In addition, symmetrical supercapacitor fabricated with the as-synthesized VN/PCNPs presents a high specific capacitance of 43.5 F g\(^{-1}\) at 0.5 A g\(^{-1}\) based on the entire cell, and an energy density of 8.0 Wh kg\(^{-1}\) when the power density was 575 W kg\(^{-1}\). Even when the power density increased to 2831.5 W kg\(^{-1}\), the energy density still remained 6.1 Wh kg\(^{-1}\).

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**Micro and Nano Systems Letters**

*Micro and Nano Systems Letters* is an international open access journal published by SpringerOpen. The MNSL offers express online publication of short research papers containing the latest advances in micro and nano-scaled devices and systems. It also offers a rapid route for the international dissemination of high quality research findings from both the micro and nano communities. Manuscripts should report new and significant findings that represent recent advances and practical applications of micro and nano systems engineering.

**Micro-fabricated flexible PZT cantilever using \( d_{33} \) mode for energy harvesting**

Hyunok Cho, Jongcheol Park, and Jae Yeong Park

https://goo.gl/Fb3eAN

**Abstract:** This paper presents a micro-fabricated flexible and curled PZT \([\text{Pb(Zr}_{0.52}\text{Ti}_{0.48})\text{O}_3]\) cantilever using \( d_{33} \) piezoelectric mode for vibration based energy harvesting applications. The proposed cantilever based energy harvester consists of polyimide, PZT thin film, and inter-digitated IrO\(_x\) electrodes. The flexible cantilever was formed using bulk-micromachining on a silicon wafer to integrate it with ICs. The \( d_{33} \) piezoelectric mode was applied to achieve a large output voltage by using inter-digitated electrodes, and the PZT thin film on polyimide layer has a remnant polarization and coercive filed of approximately \( 2P_r = 47.9 \mu \text{C/cm}^2 \) and \( 2E_c = 78.8 \text{ kV/cm} \), respectively. The relative dielectric constant was 900. The fabricated micro-electromechanical systems energy harvester generated output voltages of 1.2 V and output power of 117 nW at its optimal resistive load of 6.6 M\(\Omega\) from its resonant frequency of 97.8 Hz with an acceleration of 5 m/s\(^2\).
Cancer Nanotechnology

Recognizing cancer as a group of diseases caused by nanostructural problems (i.e. with DNA) and also that there are unique benefits to approaches inherently involving nanoscale structures and processes to treat the disease, the journal Cancer Nanotechnology aims to disseminate cutting edge research; to promote emerging trends in the use of nanostructures and the induction of nanoscale processes for the prevention, diagnosis, treatment of cancer; and to cover related ancillary areas.

Platinum nanoparticles: an exquisite tool to overcome radioresistance
Sha Li, Erika Porcel, Hynd Remita, Sergio Marco, Matthieu Réfrégiers, Murielle Dutertre, Fabrice Confalonieri, and Sandrine Lacombe

https://goo.gl/bzqZQo

Abstract:

Background: Small metallic nanoparticles are proposed as potential nanodrugs to optimize the performances of radiotherapy. This strategy, based on the enrichment of tumors with nanoparticles to amplify radiation effects in the tumor, aims at increasing the cytopathic effect in tumors while healthy tissue is preserved, an important challenge in radiotherapy. Another major cause of radiotherapy failure is the radioresistance of certain cancers. Surprisingly, the use of nanoparticles to overcome radioresistance has not, to the best of our knowledge, been extensively investigated. The mechanisms of radioresistance have been extensively studied using Deinococcus radiodurans, the most radioresistant organism ever reported, as a model.

Methods: In this work, we investigated the impact of ultra-small platinum nanoparticles (1.7 nm) on this organism, including uptake, toxicity, and effects on radiation responses.

Results: We showed that the nanoparticles penetrate D. radiodurans cells, despite the 150 nm cell wall thickness with a minimal inhibition concentration on the order of 4.8 mg L⁻¹. We also found that the nanoparticles amplify gamma ray radiation effects by >40%.

Conclusions: Finally, this study demonstrates the capacity of metallic nanoparticles to amplify radiation in radioresistant organisms, thus opening the perspective to use nanoparticles not only to improve tumor targeting but also to overcome radioresistance.
2. Materials Science

Springer Nature publishes one of the most extensive open access portfolios in materials science. From Nanoscale Research Letters to our Nature partner journals, and to our broad journals like Nature Communications and Scientific Reports, Springer Nature leads in open access materials science.

Materials Theory

Materials Theory publishes outstanding, original research articles, review articles, letters to the editor, and rapid communications in all areas of theoretical materials science and related computational methods. The scope of the journal covers problems of mechanics, physics, and chemistry of all forms of materials (metals and alloys, ceramics, polymers, functional and biological materials) at all scales and concerning the structure, synthesis, and design and performance of materials, including materials under extreme conditions. Containing novel theoretical concepts, models, and/or mathematical and computational formalisms that advance the state-of-the-art is an essential factor in accepting manuscripts submitted to Materials Theory.

Rapid Communication – Fracture as a material sink

K. Y. Volokh

https://goo.gl/jHhXtz

Abstract: Cracks are created by massive breakage of molecular or atomic bonds. The latter, in its turn, leads to the highly localized loss of material, which is the reason why even closed cracks are visible by a naked eye. Thus, fracture can be interpreted as the local material sink. Mass conservation is violated locally in the area of material failure. We consider a theoretical formulation of the coupled mass and momenta balance equations for a description of fracture. Our focus is on brittle fracture and we propose a finite strain hyperelastic thermodynamic framework for the coupled mass-flow-elastic boundary value problem. The attractiveness of the proposed framework as compared to the traditional continuum damage theories is that no internal parameters (like damage variables, phase fields, etc.) are used while the regularization of the failure localization is provided by the physically sound law of mass balance.
Diffuse-interface polycrystal plasticity: expressing grain boundaries as geometrically necessary dislocations
Nikhil Chandra Admal, Giacomo Po, and Jaime Marian

https://goo.gl/X3ke8o

Abstract: The standard way of modeling plasticity in polycrystals is by using the crystal plasticity model for single crystals in each grain, and imposing suitable traction and slip boundary conditions across grain boundaries. In this fashion, the system is modeled as a collection of boundary-value problems with matching boundary conditions. In this paper, we develop a diffuse-interface crystal plasticity model for polycrystalline materials that results in a single boundary-value problem with a single crystal as the reference configuration. Using a multiplicative decomposition of the deformation gradient into lattice and plastic parts, i.e. \( F(X,t) = F^L(X,t)F^P(X,t) \), an initial stress-free polycrystal is constructed by imposing \( F^L \) to be a piecewise constant rotation field \( R^0(X) \), and \( F^P = R^0(X)^T \), thereby having \( F(X,0) = I \), and zero elastic strain. This model serves as a precursor to higher order crystal plasticity models with grain boundary energy and evolution.

Heritage Science

Heritage Science is an open access journal publishing original peer-reviewed research covering scientific, mathematical and computational methods and analysis of objects, materials, artefacts and artworks of cultural and historical significance in the context of heritage and conservation studies.

Smartphone citizen science: can a conservation hypothesis be tested using non-specialist technology?
T. Wess

https://goo.gl/o8L4ur

Abstract: The work presented here, describes a citizen science scoping study using accessible stand-alone smartphone technology. Paper discoloration in a single journal type, the Wagga Wagga Daily Advertiser published from the dates 1876–2004 was chosen as the focus of study, with a specific hypothesis to be tested; that the wartime journals were more discolored by yellowing due to them being accessed more frequently.

A series of measurements were carried out with a smartphone device using the camera to act as a colorimeter and converting the CIE L\( \times \)xy vector length into a yellowing parameter \( Y \). A number of preliminary attempts were made to recreate conditions that corresponded to the measurements of \( Y \) using a conventional spectrophotometer, this was by standardizing distance from object and through a number of lighting conditions. It was found that the most consistently comparable results (with an offset) could be obtained using an iPhone 6S with the light source from an additional iPhone with sample to aperture distance of 4 cm.
Both studies showed that the large increase in Y occurred in journals printed around 1912 with a plateau of elevated Y value detected in journals until the 1950s after which the Y parameter decreased until 2004. This indicates the frequency access hypothesis to be false and this negative proof was able to be evidenced by the data collected by the iPhone. It would be suggested that great care needs to be taken if such an approach of stand-alone measurement were to be taken into citizen science; training and testing would need to be undertaken, because of the challenge of reproducibility and the risk of sampling irreplaceable objects.

**Applied Adhesion Science**

*Applied Adhesion Science* focuses on practical applications of adhesives, with special emphasis in fields such as oil industry, aerospace and biomedicine. Topics related to the phenomena of adhesion and the application of adhesive materials are welcome, especially in biomedical areas such as adhesive dentistry. Both theoretical and experimental works are considered for publication.

**Characterization of FeCr and FeCoCr alloy coatings of carbon steels for marine environment applications**

*Fernando José Antunes, Vinicius Ribeiro dos Santos de Sá Brito, Ivan Napoleão Bastos, and Hector Reynaldo Meneses Costa*

[https://goo.gl/JGH4Lx](https://goo.gl/JGH4Lx)

**Abstract:** This paper presents the adhesive strength results of FeCr and FeCoCr deposits produced by electric arc thermal spray process on carbon steel plates. Five chemical compositions were tested to give a large panel of possibility. Coatings were characterized by several methods to result in a performance screening. The main assessment of microstructural morphology was made by scanning electron microscopy (SEM). The mechanical strength of coatings was evaluated by standard pull-off test. The corrosion resistance was analyzed in salt-spray test. The morphology of coatings exhibits characteristics of lamellar microstructures with incompletely melted particles together with a distribution of similarly oriented oxides. The adhesive strength of FeCoCr alloy coatings was higher amongst all studied conditions. All sealed conditions presented low corrosion in salt-spray exposure. Additionally, a new FeCoCr alloy was studied to reduce pores and microcracks that are frequently found in traditional FeCr and FeCrNi alloys. Based on the performed characterizations, the findings suggested that the FeCoCr deposition, with an epoxy sealing, is suitable to be used as an efficient coating of carbon steel in aggressive marine environments.
Biomaterials Research

Biomaterials Research is an open access journal that publishes articles on all aspects of biomaterials research. The journal covers the interdisciplinary fields of biomaterials research, including novel biomaterials, cutting-edge technologies of biomaterials synthesis and fabrication, and biomedical applications in clinics and industry.

Review: Natural graft tissues and synthetic biomaterials for periodontal and alveolar bone reconstructive applications: a review
Zeeshan Sheikh, Nader Hamdan, Yuichi Ikeda, Marc Grynpas, Bernhard Ganss, and Michael Glogauer

https://goo.gl/rHpHYg

Abstract: Periodontal disease is categorized by the destruction of periodontal tissues. Over the years, there have been several clinical techniques and material options that been investigated for periodontal defect repair/regeneration. The development of improved biomaterials for periodontal tissue engineering has significantly improved the available treatment options and their clinical results. Bone replacement graft materials, barrier membranes, various growth factors and combination of these have been used. The available bone tissue replacement materials commonly used include autografts, allografts, xenografts and alloplasts. These graft materials mostly function as osteogenic, osteoinductive and/or osteoconductive scaffolds. Polymers (natural and synthetic) are more widely used as a barrier material in guided tissue regeneration (GTR) and guided bone regeneration (GBR) applications. They work on the principle of epithelial cell exclusion to allow periodontal ligament and alveolar bone cells to repopulate the defect before the normally faster epithelial cells. However, in an attempt to overcome complications related to the epithelial down-growth and/or collapse of the non-rigid barrier membrane and to maintain space, clinicians commonly use a combination of membranes with hard tissue grafts. This article aims to review various available natural tissues and biomaterial based bone replacement graft and membrane options used in periodontal regeneration applications.
3. Physics and optics of materials

Journal of the European Optical Society – Rapid Publications

The Journal of the European Optical Society—Rapid Publications (JEOS:RP) aims to tackle a wide range of both fundamental and applied optics topics in the form of prompt, scientific, high-quality communications that report on the latest findings. It presents emerging technologies and outlining strategic goals in optics and photonics.

Experimental investigation of the propagation properties of bloch surface waves on dielectric multilayer platform
Richa Dubey, Elsie Barakat, Markus Häyrinen, Matthieu Roussey, Seppo K. Honkanen, Markku Kuittinen, and Hans Peter Herzig

https://goo.gl/ju7BnC

Abstract:

Background: The periodic dielectric multilayers sustaining Bloch surface waves have been proposed as a platform for the sensing applications and the two dimensional integrated optics. In this paper, we present the experimental and theoretical investigation of propagation properties of Bloch surface waves, for example propagation length and refractive index of the surface mode, at the interface of a dielectric multilayer platform. We use thin layers (~λ/25) of titanium dioxide as an additional layer of high index material.

Methods: We exploit multi-heterodyne scanning near-field optical microscopy and total internal reflection configuration as a near-field and far-field characterization tools.

Results: The longest propagation length is achieved when the multilayer is designed to have the dispersion curve positioned close to the middle of the photonics band gap. We measure a Bloch surface wave mode of propagation length 3.24 mm and of an effective refractive index contrast 0.15.

Conclusions: The experimental results are in conformity with theoretical results. This study paves a way to realize efficient and compact two dimensional components and systems.
Nonlinear optical response of Mg/MgO structures prepared by laser ablation method
Fahimeh Abrinai
https://goo.gl/YkDdNr

Abstract:

Background: Investigation of new materials plays an important role in advancing the field of optoelectronics.

Methods: In this work, Mg/MgO microstructures were prepared by Nd-YAG laser (λ= 1064 nm) ablation of magnesium target in acetone. For the first time, the nonlinear optical properties of square Mg/MgO microstructures were investigated by using the Z-scan technique with nanosecond Nd-YAG laser at 532 nm.

Results: The XRD analysis approved the formation of Mg/MgO microstructures. The energy band gap of Mg/MgO microstructures was calculated to equal 2.3 eV from UV-Vis spectrum. The ablated materials were ejected into acetone as structures with an average size of 1-1.5 μm. The nonlinear absorption coefficient, β, and nonlinear refractive index, n², for Mg/MgO microstructures at the laser intensity of 1.1 × 10⁸ W/cm² were measured to be 1.15 × 10⁻⁸ cm/W and 8.2 × 10⁻¹³ cm²/W, respectively. In order to investigate size particles and liquid medium effects, the nonlinear optical parameters, β and n₂, of Mg/MgO nanostructures synthesized by laser ablation of magnesium target in isopropanol also were calculated and it was found these parameters are an order of magnitude larger than the values for the β and n₂ of Mg/MgO microstructures synthesized in acetone. The third-order nonlinear optical susceptibility, χ(3), of Mg/MgO microstructures and nanostructures were measured in order of 10⁻⁶ and 10⁻⁵ esu, respectively.

Conclusions: The results show that Mg/MgO structures synthesized in acetone and isopropanol have negative nonlinearity as well as good nonlinear absorption at 532 nm and these magnesium-based structures have the potential applications in the nonlinear optical devices.

Plasmonic behavior of III-V semiconductors in far-infrared and terahertz range
Jan Chochoł, Kamil Postava, Michael Čada, Mathias Vanwolleghem, Martin Mičica, Lukáš Halagačka, Jean-François Lampin, and Jaromír Pištora
https://goo.gl/o6BFyo
Abstract:

**Background:** In this article, III-V semiconductors are proposed as materials for far-infrared and terahertz plasmonic applications. We suggest criteria to estimate appropriate spectral range for each material including tuning by fine doping and magnetic field.

**Methods:** Several single-crystal wafer samples (n,p-doped GaAs, n-doped InP, and n,p-doped and undoped InSb) are characterized using reflectivity measurement and their optical properties are described using the Drude-Lorentz model, including magneto-optical anisotropy.

**Results:** The optical parameters of III-V semiconductors are presented. Moreover, strong magnetic modulation of permittivity was demonstrated on the undoped InSb crystal wafer in the terahertz spectral range. Description of this effect is presented and the obtained parameters are compared with a Hall effect measurement.

**Conclusions:** Analyzing the phonon/free carrier contribution to the permittivity of the samples shows their possible use as plasmonic materials; the surface plasmon properties of semiconductors in the THz range resemble those of noble metals in the visible and near infrared range and their properties are tunable by either doping or magnetic field.

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**Design and characterization of a linear quadrupole ion trap for high-resolution Coulomb-crystal time-of-flight mass spectrometry**

*Daniel Rösch, Hong Gao, Ardita Kilaj, and Stefan Willitsch*

https://goo.gl/ujgqzg

**Abstract:** We present and discuss in detail the design and characterization of a new linear quadrupole ion trap with additional ion ejection and acceleration electrodes that is coupled to a time-of-flight mass spectrometer. Mass spectra of Coulomb crystals consisting of Ca⁺, CaO⁺ and CaOH⁺ ions were recorded with a post-ejection-acceleration scheme yielding a mass resolution of $m/\Delta m \approx 700$. The second order rate constant for the reaction $\text{Ca}^+ + \text{N}_2\text{O} \rightarrow \text{CaO}^+ + \text{N}_2$ was measured to test the usability of this apparatus for ion-molecule reaction studies. The rate constant was found to be $5.49(32) \times 10^{-11}\text{cm}^3\text{s}^{-1}$ which is compared with previous literature values. Owing to the high mass resolution achieved, the present instrument is an ideal tool for the study of the products of complex chemical reactions involving Coulomb crystals.
Sympathetic cooling of molecular ions with ultracold atoms

Eric R. Hudson

https://goo.gl/QEWj7r

Abstract: Sympathetic cooling of molecular ions with ultracold gases is enabling a new era of research in chemistry and physics. There has been much progress in this new field in the last several years and many unanticipated challenges have been overcome. The aim of the present manuscript is to provide a concise review of this work and discuss the way forward for the field.

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Silicon nanophotonics for scalable quantum coherent feedback networks
by Mohan Sarovar, Daniel BS Soh, Jonathan Cox, Constantin Brif, Christopher T DeRose, Ryan Camacho, and Paul Davids

https://goo.gl/hMVRdW

Abstract: The emergence of coherent quantum feedback control (CQFC) as a new paradigm for precise manipulation of dynamics of complex quantum systems has led to the development of efficient theoretical modeling and simulation tools and opened avenues for new practical implementations. This work explores the applicability of the integrated silicon photonics platform for implementing scalable CQFC networks. If proven successful, on-chip implementations of these networks would provide scalable and efficient nanophotonic components for autonomous quantum information processing devices and ultra-low-power optical processing systems at telecommunications wavelengths. We analyze the strengths of the silicon photonics platform for CQFC applications and identify the key challenges to both the theoretical formalism and experimental implementations. In particular, we determine specific extensions to the theoretical CQFC framework (which was originally developed with bulk-optics implementations in mind), required to make it fully applicable to modeling of linear and nonlinear integrated optics networks. We also report the results of a preliminary experiment that studied the performance of an in situ controllable silicon nanophotonic network of two coupled cavities and analyze the properties of this device using the CQFC formalism.

Mitigating radiation damage of single photon detectors for space applications
by Elena Anisimova, Brendon L Higgins, Jean Phillippe Bourgoin, Miles Cranmer, Eric Choi, Danya Hudson, Louis P Piche, Alan Scott, Vadim Makarov, and Thomas Jennewein

https://goo.gl/K36R1R

Abstract: Single-photon detectors in space must retain useful performance characteristics despite being bombarded with sub-atomic particles. Mitigating the effects of this space radiation is vital to enabling new space applications which require high-fidelity single-photon detection. To this end, we conducted proton radiation tests of various models of avalanche photodiodes (APDs) and one model of photomultiplier tube potentially suitable for satellite-based quantum communications. The samples were irradiated with 106 MeV protons at doses approximately equivalent to lifetimes of 0.6, 6, 12 and 24 months in a low-Earth polar orbit. Although most detection properties were preserved, including efficiency, timing jitter and afterpulsing probability, all APD samples demonstrated significant increases in dark count rate (DCR) due to radiation-induced damage, many orders of magnitude higher than the 200 counts per second (cps) required for ground-to-satellite quantum communications. We then successfully demonstrated the mitigation of this DCR degradation through the use of deep cooling, to as low as −86°C. This achieved DCR below the required 200 cps over the 24 months orbit duration. DCR was further reduced by thermal annealing at temperatures of +50 to +100°C.
Laser annealing heals radiation damage in avalanche photodiodes

Jin Gyu Lim, Elena Anisimova, Brendon L Higgins, Jean-Phillippe Bourgoin, Thomas Jennewein, and Vadim Makarov

https://goo.gl/PECegd

Abstract: Avalanche photodiodes (APDs) are a practical option for space-based quantum communications requiring single-photon detection. However, radiation damage to APDs significantly increases their dark count rates and thus reduces their useful lifetimes in orbit. We show that high-power laser annealing of irradiated APDs of three different models (Excelitas C30902SH, Excelitas SLiK, and Laser Components SAP500S2) heals the radiation damage and several APDs are restored to typical pre-radiation dark count rates. Of nine samples we test, six APDs were thermally annealed in a previous experiment as another solution to mitigate the radiation damage. Laser annealing reduces the dark count rates further in all samples with the maximum dark count rate reduction factor varying between 5.3 and 758 when operating at −80°C−80°C. This indicates that laser annealing is a more effective method than thermal annealing. The illumination power to reach these reduction factors ranges from 0.8 to 1.6 W. Other photon detection characteristics, such as photon detection efficiency, timing jitter, and afterpulsing probability, fluctuate but the overall performance of quantum communications should be largely unaffected by these variations. These results herald a promising method to extend the lifetime of a quantum satellite equipped with APDs.
Notes
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