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ספר התקצירים

אלה שמתאהבים בבעיה
הם אלה שממציאים לה פתרון

Preparation by Electrophoretic Deposition and Characterization of MXene and MXene-TiO_2 Films

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Abstract

MXenes, discovered in 2011, are the latest and least understood two-dimensional (2D) materials. It is a family of 2D transition metal carbides and nitrides that have attracted the attention of the scientific community, owing to their remarkable unique characteristics of high specific surface area, conductivity, hydrophilic surfaces, and as recently discovered biocompatibility. It has been suggested that catalytic materials derived from MXenes can be engineered to be both stable and active; thus, they can be integrated in green energy conversion applications. The motivation of this study was to prepare MXene and MXene-TiO2 films by electrophoretic deposition (EPD), which can be used for energy system, and enhanced their corrosion resistance. Since the electrochemical oxidation of MXenes is ruinous to activity and conductivity, the use of MXenes in electrochemical applications is limited. Hence, the doping of MXene with a noble compound was investigated, under the assumption that TiO2 addition would increase the stability of which.

The preparation and characterization of MXene and MXene-TiO2 films by electrodeposition process and their morphology are addressed in the study. The deposited films were characterized by scanning electron microscopy (SEM), X-ray diffraction (XRD) and X-ray photoelectron spectroscopy (XPS). The latter was conducted to identify the phases in the deposit MXene-TiO2 films compared to those of the MXene films. The susceptibility of the deposited MXene films to localized corrosion and their oxidation/repassivation behavior were evaluated. Furthermore, the effects of TiO2 incorporation into MXene were studied. Corrosion measurements were conducted by the cyclic potentiodynamic polarization (CPP) technique.

According to the results, the deposition processes of MXene and MXene-TiO2 films were successfully performed. The study reveals that the film composition and properties could be controlled by changing the applied voltage and duty cycle. The beneficial effect of TiO2 nanoparticles on the electrochemical oxidation resistance of MXene was demonstrated.

Determination of Thermal Expansion Coefficients of Single Crystals Using X-Ray Diffraction

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Abstract

Thermal expansion is a common physical property of materials that describes mechanical deformation in response to the change of a temperature. This property is important on its own, e.g., for fuel containers which are always subject to temperature changes, and due to its connection with other properties, such as melting point and self-diffusion. Mathematically, a thermal expansion coefficient is represented by a second rank tensor. It describes the relationship of second rank tensor strain and a temperature change (a scalar). The number of independent components of the coefficient depends on the point symmetry of the material of interest. Using single-crystal X-ray diffraction, it is possible to determine the components of this strain experimentally. This project focuses on the development of the protocol for such measurement at the single crystal four-circle X-ray diffractometer in the laboratory of functional materials in Tel Aviv University. The second goal of this project is to measure the thermal expansion coefficients in a silicon and a sucrose single crystals. A sucrose single crystal was grown by evaporating water from a saturated sucrose solution. We implemented the analysis based on the shape and position of ω- (for silicon crystal) and 2θ- (for sucrose crystal) Bragg peak profiles. Using ω-dependence of the diffraction intensities provides one order of magnitude better angular resolution, while using 2θ-dependence is easier to analyze. For the silicon crystal, we obtained the thermal expansion coefficient $\alpha = 3.88(7) \times 10^{-6}\ \mathrm{K}^{-1}$. For the sucrose crystal, we obtained that four independent components of thermal expansion tensor are: $\alpha_{11} = 4.434(6) \times 10^{-5}, \alpha_{22} = 4.915(4) \times 10^{-5}\ , \alpha_{33} = 1.90(2) \times 10^{-5}\ , \alpha_{13} = -1.1461(1) \times 10^{-5}\ \mathrm{K}^{-1}$.

Easy to Print Electrically Conductive PLA/Graphene's Filler Design Recommendations

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Abstract

In recent years 3D printing of composites is at the center of many papers, due to reports of excellent electrical and mechanical properties of those composites. One of those composites is PLA/Gn (poly lactic-acid matrix, with graphene as a filler). PLA is a very common matrix, thanks to its low melting point which enables easy printing, and its environmental-friendly attributes. Graphene became a popular filler owing to its exceptional electrical and mechanical properties. This project focuses on how to optimize the graphene configuration in PLA/Gn. In order to do so, five commercial PLA/Gn filaments for a fused deposition modeling printer were examined and found to be either easy to print, or electrically conductive, but not both. While higher loading of graphene leads to the construction of a conductive network throughout the composite, it also decreases its yield strength. This duality can cause an insufficient product of electrically conductive PLA/Gn filament. To study this problem, measurements of tensile test, thermogravimetric analysis, four-point probe were taken. Also, several images from a scanning electron microscope of the commercial PLA/Gn filaments were examined. By analyzing the results and reviewing the relevant literature, several conclusions were obtained: the graphene content in the composite should exceed the percolation threshold (2.5-3.0 wt.%) but needs to preserve the PLA's elasticity; generation of Gn aggregation enhances both the mechanical and electrical properties of the composite; lastly, the higher the aspect ratio of Gn, the more aggregation will be generated, but it will also contribute to the embrittlement of the composite. From those conclusions three main recommendations were derived: Graphene loading should be between 3-10wt.%; aggregation must be generated; and the aspect ratio of the fillers must be in inverse ratio to the graphene loading. By following these suggestions, an easy to print electrically conductive PLA/Gn filament should be achieved.

Directed Motion by Injection of Information: Hexbugs and Mini-RC Car in a Flexible Circle Loop-Shaped Boundary

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Abstract
Swarm robotics explore the possibility of having several simple robots perform together complex tasks. Using the phenomenon of aggregation and collective motion, we set an experiment use a small swarm of simple active particles in the form of bristle robots confined in a flexible and deformable circular frame, which is also used as cargo they transport. In order to direct the motion of the robots' cluster, we added an informed robot to the system - in the form of a mini- RC car, that is too weak to move the cargo but can direct the swarm. We examine a variable number of particles, whether and in what percentage they reach the target, first passage time, characterize the diffusion and angular diffusion, mean square displacement, velocity, and average direction. We do this both by experiments and by a simulation described by the Langevin equation. Turned around, this system can be viewed as a novel type of information engine that converts injected information to motion rather than extracting information to produce work. We show that a single week informed agent can direct the collective motion of a small swarm of simple robots, similar to leaders of herds in nature. Furthermore, small swarms are more easily directed at the price of less power. In the future, we intend to test the robustness of small swarms in passing obstacles or narrow passages at the presence of an informed agent.

Enhanced Sensitivity in Immunoassays via Implementation of Ultra-high Surface Area Nanostructured Substrates

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Abstract

Immunoassays are one of the most employed methods for bio-sample analysis due to their speed, precision, and availability. However, due to an increasing understanding of the significance of low abundance proteins and biomarkers, there is demand for higher resolution quantitative methods for bio-sample analysis. This work presents the viability of implementation of highly ordered ultra-high surface area nanostructured arrays as immunoassay substrates. The arrays were fabricated using a silver-catalyzed wet etching process and their performance was tested by performing a fluorescence immunoassay. The implementation of Silicon NanoPillars(SiNP) and Branched Silicon NanoPillars(BSiNP) arrays yielded a 2 orders of magnitude improvement in the limit of detection, allowing analysis of a sample with a concentration as small as 0.375nM under the given experimental conditions. It has been demonstrated that SiNPs arrays offer a lower limit of detection than BSiNPs arrays and an increase in the pillar length improves the array performance. However, BSiNPs prove more advantageous in the case of higher concentration samples.

Platform Selection of Molybdenum Disulfide for Precious Metal Recovery Applications

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Abstract
The increasing industrial demand for precious metals in the last decades results in consideration of recycled resources to balance between energy consumption and cost-effectivity. Silver (Ag), for instance, has an enormous commercial value and thus should be recovered from wastes, especially when considering its potential environmental risk. Molybdenum disulfide (MoS_2) nanosheets have demonstrated selective and efficient adsorption potential toward heavy metals, but their practical application to recover precious metals was never tested before. Specifically, the utility of nano-based technologies is highly dependent on the material design as well as process design. For example, affixing these nanomaterials onto support layers may be beneficial for recovery applications due to the importance of (i) increasing surface area and corresponding active sites of the nanomaterial, (ii) minimizing its release into the treated water, and (iii) allowing high desorption rates and effective recovery of the composite in harsh acidic/basic conditions.

In this study, we aimed to choose an optimal support material of MoS_2 for recovery of precious metals from wastes. We tested three optional platforms: sand, alumina, and PTFE beads, on which we synthesized MoS_2 using bottom-up hydrothermal methods. We managed to create a stable homogenous MoS_2 coating over sand and alumina, while PTFE beads were only partially coated. Then, we examined the hybrid adsorbents (i.e., MoS_2@Sand/Alumina/PTFE) ability to allow efficient, sustainable, and safe metal adsorption. We used three criteria for the selection of an optimal platform; efficiency criterion was used to evaluate the support effect on the nanomaterial performance, sustainability criterion was used to assess the nanocomposite ability to be used for multiple cycles, and scalability criterion was used to estimate the commercial viability and readiness of the platforms suggested. Our study indicates that, among the platforms tested, alumina beads are the optimal platform for molybdenum disulfide for precious metal recovery applications.

Correlation between Printing Process Parameters and the Defects Created in AlSi10Mg Alloy Parts

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Abstract

In recent years, selective laser melting (SLM), one of the metal additive manufacturing (AM) techniques have developed and received significant attention from both the academic and industrial sectors. It allows the production of parts with complex geometries with minimal waste of material, thus, reduces the design-to-manufacture time, and is environment friendly.

Aluminum alloys produces by SLM are commonly investigated in various fields of interest.

They are widely used in the automotive and aerospace industries thanks to an excellent combination of low density and excellent mechanical properties.

MBT-IAI faces high production rates of operational systems, which contain printed metal and plastic parts. Thus, the economic aspect and time, together with quality requirements play a crucial role in the industry. In the additive manufacturing (AM) process, the process parameters can be changed which directly affect the microstructure of the material and the mechanical properties obtained. Changing the process parameters, can lead to undesired defects in the produce such as cracks, porosity, and lack of fusion. In previous work, despite the presence of defects in the parts, the behavior of the static mechanical properties did not show a clear correlation between the defects and the material properties.

In this study, we developed cost-effective method of screening the amount of defects in samples, during the stages of printing process development. This was done by correlating the amount of defects created in samples, printed in different manufacturing parameters from AlSi10Mg alloy powder, and the results of different examination methods such as X-ray radiography, metallographic cross-section inspection and Archimedes density measurement.

The screening is required in order to reach process parameters that will yield a 99.5% density minimum, which is MBT's manufacturing goal for the serial production parts.

Microneedle Embedded Nanosensors Array for Minimally Invasive Biomarkers Detection by Blood Extraction-free Method.

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Abstract

This work will discuss and present silicon nanowire field-effect transistor-based microneedle array for protein detection and quantification in the sub-pM range. The microneedle array allows biomarkers sensing directly from blood requiring less than 1 µl sample. The 2D top-down fabricated techniques resulting in 3D functionality using common micromachining techniques allow for easy integration of drug delivery systems, redundancy of sensors for reliable results and multiplex detection on a single device. Additionally, the surface of the microneedles was modified for the biomarker prostate-specific antigen (PSA) sensing experiments. *In-vitro* and *ex-vivo* measurements using the microneedle array sensors were demonstrated on human blood. The detection resulted in a direct correlation with results taken from clean serum using ELISA measurements, proving the ability to measure the target protein accurately. The motivation for this work was to create an accurate, sensitive, fast, and minimally invasive sensing device that will replace the invasive, time-consuming, and painful blood tests.

Effect of polycaprolactone (PCL) matrices on bio-composite material systems: towards aortic valve replacement

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Abstract

An aortic valve replacement is common and used to treat aortic valve diseases. There are two main aortic valve diseases: aortic stenosis – where the valve is narrowed, restricting blood flow; and aortic regurgitation – where malfunctioning of the valve causes blood to leak back into the heart. These problems can be congenital or can develop later in life.

Two main prosthetic aortic valves are commonly used for the treatment of aortic valve diseases:

Mechanical valves - the main advantage of these replacements is that they are hard-wearing and less likely to need replacing. But on the other hand, the mechanical valve can lead to blood clots to form on the valve, so lifelong treatment with anticoagulant medications such as warfarin is needed to prevent it.

In addition, these medications can increase the possibility to have excessive bleeding from a cut or injury.

Biological or tissue valves (also called bioprosthetic valves): the main advantage of this replacement is that there is less risk to have clots forming, so lifelong anticoagulant treatment is not necessary. However, in the long run, structural degradation is a significant risk.

Currently, the perfect prosthetic valve that mimics the morphology and the mechanical behavior of native AV does not exist

The main goal of the project is to develop a new bio-composite material that will be used to construct an engineered aortic valve, made from hybrid materials: soft coral collagen fibers and Polycaprolactone (PCL)-based matrix in order to enhance the mechanical properties.

In order to produce the matrix fiber of the composite material we used electrospinning method. The electrospun matrix was placed on both sides of a frame containing the wrapped collagen fibers, creating a bio composite structure. All the samples underwent tensile tests to characterize their mechanical properties.