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Influence of laser processing conditions for the manufacture of microchannels on ultrahigh molecular weight polyethylene coated with PDMS and PAA

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Abstract

Ultrahigh molecular weight polyethene (UHMWPE) is employed as a bearing material in a range of applications due to its improved elasticity, compatibility, and impact resistance, processing conditions for a suitable surface texture are necessary. Surface texture processing on microchannels using lasers is always associated with the effect of heat damage on the polymer specimen surface. This study aims to explore the use of polydimethylsiloxane (PDMS) and polyacrylic acid (PAA) in the form of liquid gel coatings in order to reduce heat damage to surfaces during the laser processing of ultrahigh molecular weight polyethene (UHMWPE). First, PDMS and PAA were coated on the surface of the UHMWPE material specimen, and then texturing was performed using a laser diode and cleaned using the

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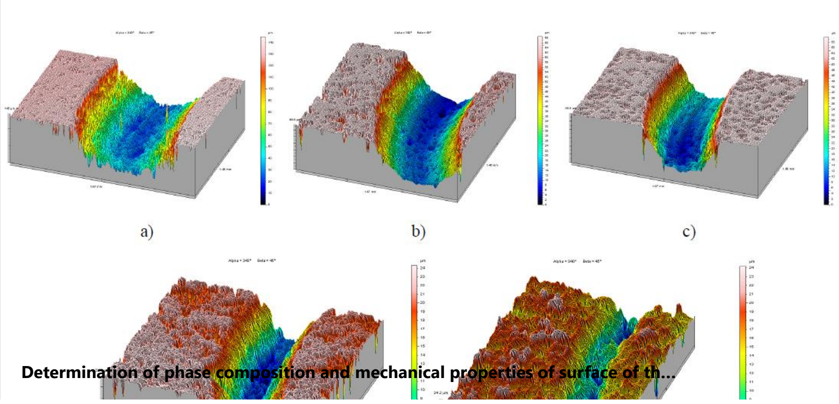

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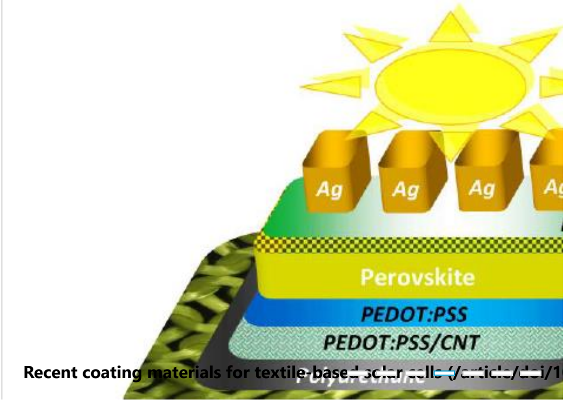

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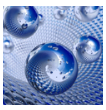

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Influence of laser processing conditions for the manufacture of microchannels on ultrahigh molecular weight polyethylene coated with PDMS and PAA

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Abstract: Ultrahigh molecular weight polyethene (UHMWPE) is employed as a bearing material in a range of applications due to its improved elasticity, compatibility, and impact resistance, processing conditions for a suitable surface texture are necessary. Surface texture processing on microchannels using lasers is always associated with the effect of heat damage on the polymer specimen surface. This study aims to explore the use of polydimethylsiloxane (PDMS) and polyacrylic acid (PAA) in the form of liquid gel coatings in order to reduce heat damage to surfaces during the laser processing of ultrahigh molecular weight polyethene (UHMWPE). First, PDMS and PAA were coated on the surface of the UHMWPE material specimen, and then texturing was performed using a laser diode and cleaned using the ultrasonic method. Second, the dimensions and texture profiles of all the samples from this study were measured using a confocal microscope and open source software. In addition, the effect of adding liquid gel on the surface at 150 μm thickness and laser power parameters was determined. The results show that the PDMS and PAA liquid gel layers help regulate the dimensional bulge of the fabricated microchannels at laser powers below 6 watts, compared to those produced without the coating.

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Research article

Circular self-cleaning building materials and fabrics using dual doped TiO_2 nanomaterials

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Abstract: Nanostructured titanium dioxide (TiO_2) among other oxides can be used as a prominent photocatalytic nanomaterial with self-cleaning properties. TiO_2 is selected in this research, due to its high photocatalytic activity, high stability and low cost. Metal doping has proved to be a successful approach for enhancing the photocatalytic efficiency of photocatalysts. Photocatalytic products can be applied in the building sector, using both building materials as a matrix, but also in fabrics. In this study undoped and Mn-In, Mn-Cu, In-Ni, Mn-Ni bimetallic doped TiO_2 nanostructures were synthesized using the microwave-assisted hydrothermal method. Decolorization efficiency of applied nanocoatings on fabrics and 3-D printed sustainable blocks made from recycled building materials was studied, both under UV as well as visible light for Methylene Blue (MB), using a self-made depollution and self-cleaning apparatus. Nanocoated samples showed high MB decolorization and great potential in self-cleaning applications. Results showed that the highest MB decolorization for both applications were observed for 0.25 at% Mn-In doped TiO_2. For the application of 3-D printed blocks Mn-In and In-Ni doped TiO_2 showed the highest net MB decolorization, 25.1 and 22.6%, respectively. For the application of nanocoated fabrics, three samples (Mn-In, In-Ni and Mn-Cu doped TiO_2) showed high MB decolorization (58.1, 52.7 and 47.6%, respectively) under indirect sunlight, while under UV light the fabric coated with Mn-In and In-Ni doped TiO_2 showed the highest MB decolorization rate 26.1 and 24.0%, respectively.

Keywords: nanomaterials; TiO_2; doping; self-cleaning; anti-pollution; decolorization; circular building materials; fabrics

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Research article

Pure TiO_2/PSi and TiO_2@Ag/PSi structures as controllable sensor for toxic gases

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Abstract: In this research, two pellets of titanium dioxide TiO_2 were prepared at room temperature. The first was pure titanium dioxide, and the other was doped with silver (2.5%). The pellets were deposited on porous silicon (PSi) with the pulsed laser deposition (PLD) technique. The results of scanning electron microscopy and energy-dispersive X-ray spectroscopy showed improvements in the surface morphologies of the TiO_2/PSi and TiO_2@Ag/PSi composites. The composites were then tested as CO_2 gas sensors. The electrical measurements of the composites showed a decrease in the electrical resistance of the CO_2 gas sensor doped with a metal. Sensitivity to CO_2 increased to up to 55% in Ag-doped TiO_2 film with a concentration of 2.5%, and the highest sensitivity value was obtained in the pure titanium dioxide film (26%).

Keywords: porous silicon; photo-electrochemical etching; titanium oxide; pulsed laser deposition; sensitivity; gas sensor

1. Introduction

Porous silicon (PSi) has attracted considerable interest in recent years because of its unique physical and optical properties and many applications in technological fields, including optical electronics and sensors [1,2]. These characteristics are achieved by increasing its surface area in relation to its volume and the number of pores per unit volume [3]. Methods for producing PSi include the wet and galvanic methods and methods using metals. These methods are inexpensive, simple and efficient in preparing Psi [4,5]. PSi prepared with one of the etching methods shows new properties. The ordinary silicon, with an indirect energy gap of 1.12 eV, changes to PSi, with a direct