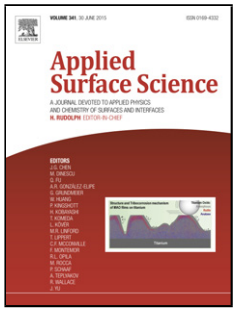

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Surface functionalization of cyclic olefin copolymer (COC) with evaporated TiO_2 thin film

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Abstract

Cyclic olefin copolymer (COC) is a new class of thermoplastic polymers used for a variety of applications ranging from bio-sensing to optics. However, the hydrophobicity of native COC hampers the further development and application of this material. In this work, we report the structural, morphological, and optical properties of the TiO_2/COC hybrid material, which provides a desirable substrate for optical devices and subsequent surface modifications. The TiO_2 film on COC substrate was deposited by the evaporation method, and it was characterized by X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), profilometry and atomic force microscope (AFM). Using an UV-vis spectrophotometer, we found that the transmittance of the TiO_2/COC hybrid material in the visible domain reached 80 %. The TiO_2/COC hybrid appeared to be stable in most of the assessed polar solvents and acid/basic solutions. The new TiO_2/COC hybrid material and the robust fabrication method are expected to enable a variety of BioMEMS applications.

Keywords: COC, TiO_2-COC, surface modifications, evaporation, XPS, XRD, AFM, UV-Vis spectroscopy, roughness, solvents.
2010 MSC: 00-01, 99-00

1. Introduction

In recent years polymers have gained a significant attention as promising materials for rapid prototyping. Various polymers with diverse properties provide practical, versatile and cost-effective alternatives to inorganic substrates (i.e. silicon or glass) for the fabrication of micro-devices. There are many polymeric materials, e.g., poly(methyl methacrylate) (PMMA) [1], polycarbonate (PC)[2], polydimethylsiloxane (PDMS)[3], and cyclic olen copolymers (COCs) [4]. The COCs are of special interest, because they have some unique properties compared to the formentioned materials [5] - [6]. COCs have drawn special attention due to its desirable properties such as high glass transition temperature, low autofluorescence, optical clarity, resistance to organic solvents, low water uptake and moldability [7] - [8]. The COC is based on the polymerization of ethylene and norbornene using metallocene catalysts. This material can have a glass-transition temperature (Tg) ranging from 33 °C to 180 ° C [9], depending on the comonomer ratio.

The COC has been used in micro-electrical-mechanical systems (MEMS)[10] - [11] and micro total analysis systems (TAS)[12]. Not very expensive and easily replicable fabrication techniques such as injection molding and hot embossing [13] have been used extensively and successfully on the COC. Although COC based microfluidic devices have been widely used, there are some limitations. Most synthetic polymers have a chemically inert and highly hydrophobic surface. The hydrophobic surface will create significant difficulties for liquid injection and flow control in microfluidic channels. The lack of functional surface groups for

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