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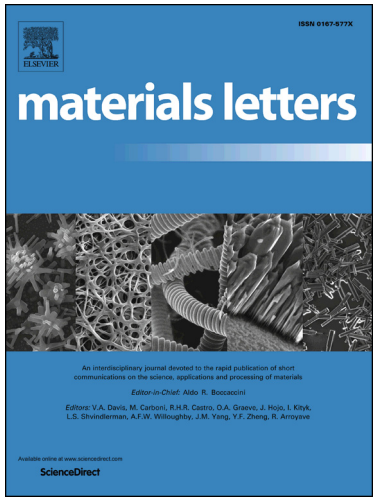

Facile photo-induced growth of polymeric nanostructures onto cellulose: The poly(ethylene glycol) methacrylate (PEGMA)@cellulose case study

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Facile photo-induced growth of polymeric nanostructures onto cellulose: The poly(ethylene glycol) methacrylate (PEGMA)@cellulose case study

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Abstract

Photo-polymerization is a polymerization method widely exploited in many technological fields, due to its high versatility and fast reaction rates. In this study, poly(ethylene glycol) methacrylate (PEGMA) nanostructures are grown onto cellulose following a simple and promising light-driven reaction mechanism involving benzophenone (as photo-initiator) and UV-curing. The effectiveness of the surface functionalization has been determined by means of morphological and physicochemical characterizations, showing the formation of very sharp PEGMA nanometric architectures.

Keywords: Biopolymers; Cellulose; Fibre technology; Materials science; Nanomaterials; Surfaces.

1. Introduction

In the last decades, the exploitation of natural resources to produce advanced bio-based materials has been extensively investigated as a valid (and sustainable) alternative to the more conventional fossil-derived materials, following the "green chemistry" guidelines [1-4]. In particular, the possibility of introducing "smart" functionalities onto natural materials to confer particular capabilities is more and more becoming a mandatory requirement for the development of novel functional (and engineering) materials [5-8]. To date, many researches are involved in both the surface modification and growth of nanostructures onto natural fibers (mostly cellulose) [9-12].
According to the literature, the grafting of poly(ethylene oxide) moieties onto cellulose has been investigated to prepare stimuli-responsive materials for application in (bio)sensing and/or drug delivery [13-14], thus making this platform possibly exploited in sensing and biomedicine [15]. However, most of the methods investigated required the use of tedious and complex synthetic pathways [16]. In this context, a promising option is to choose for more eco-friendly routes such as the light-driven growth of poly(ethylene glycol) methacrylate (PEGMA) onto activated cellulose by covalently bonding this acrylic polymer onto cellulose following a photo-curable approach [17]. In the present work, we present a simple and versatile functionalization approach, to obtain PEG grafting onto cellulose via photo-polymerization by exploiting the UV-curable acrylic units of the PEGMA polymer. The activation of the biopolymer surface was performed by using a benzophenone mediated mechanism [18]. Such light-driven functionalization is a simple (and efficient) two-step process, consisting in the cellulose surface photo-activation and the photo-polymerization of PEGMA polymer grafted at the cellulose surface.

2. Materials and methods

2.1. Reagents and chemicals

For the production of the PEGMA@cellulose, cellulose powder (CAS 9004-34-6, Carlo Erba reagents) was used as starting substrate. Benzophenone (CAS 119-61-9, purity 99%, Merks) was selected as photo-initiator, whereas poly(ethylene glycol) methacrylate (PEGMA, CAS 25736-86-1, average M_n = 500 g mol^{-1}, Merck) was selected as photo-polymer. Both reactions (i.e., surface photo-activation and PEGMA photo-polymerization) were carried out in tetrahydrofuran (THF,