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Chemical functionalization of Xanthan gum for the dispersion of double-walled carbon nanotubes in water

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ABSTRACT

Achieving stable suspensions of carbon nanotubes (CNTs) in water is still a challenge. Addition of surfactants is desirable as it allows keeping intact the intrinsic properties of the CNTs. However, for different applications, the potential toxicity of the surfactant is an important issue. Polysaccharides are among the best candidates and chemical modification can improve their intrinsic features. They can thus combine the properties of added synthetic counterparts with their intrinsic biocompatibility. In this work, we focused on the synthesis of hydrophobically modified Xanthan (Xan) with three derivatives (Diphenylmaleic anhydride, Phtalic anhydride, Epichlorhydrin-Phenol) to disperse CNTs. The dispersion and the stability against sedimentation of double walled carbon nanotubes (DWCNTs) have been investigated (rheological properties, zeta potential) as a function of pH and Xan concentration. Our results show that stable suspension of DWCNTs for 0.5% (w/w) could be obtained with the three derivatives of modified Xanthan gum in acidic and alkaline media while Xan itself is a very poor dispersing agent for CNTs, giving good evidence of the validity of our approach.

1. Introduction

Due to their exceptional physical and chemical properties, such as excellent mechanical strength, high electrical and thermal conductivities, high specific surface area, low density, and high aspect ratio [1,2], CNTs have attracted considerable attention of researchers in various fields of research. Nevertheless, their insolubility in organic or aqueous media is a major bottleneck in the exploitation of these excellent properties because CNTs tend to agglomerate into bundles due to strong Van der Waals attractions forces. The poor solubility of CNTs turns dispersion into a challenge and several studies have already been published to achieve a uniform dispersion in aqueous or organic media. Both covalent [3–6] and non-covalent [7,8] functionalizations of CNTs have been reported. However, a major drawback of covalent functionalization such as oxidizing treatment by the use of appropriate acids at high temperature (nitric acid alone, or in combination with sulfuric acid) is the disruption of the extended π-conjugation in CNTs, resulting into structural defects on the nanotubes and leading to decreased (or at least modified) electrical and mechanical properties [9,10]. In contrast, the non-covalent approaches usually involve ultrasonication, centrifugation and filtration, focus on spurring non-disruptive interactions such as π–π stacking, adsorption, or Coulomb interactions through insertion of a chemical bridging agent [11], with

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