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Stimuli Responsive Cellulose Nanocrystals by Radiation-induced Graft Polymerization of N-isopropyl acrylamide (NIPAm)

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PURPOSE OF THE ABSTRACT

Surface modification is a key strategy for tailoring the properties and the behavior of nanoparticles in specific environments. Cellulose nanocrystals (CNC) exhibit at their surface a large density of potentially reactive anhydroglucose units, while having a very stable core structure and unique aspect ratio. Various methods have been used to convert the hydrophilic and polar surface of the CNC by ionic interactions with surfactants, by chemical coupling to hydroxyl groups or by polymer grafting. However, radiation grafting onto NCC seems to have received little attention in the literature, in spite of its unique advantages.

We are currently studying the graft polymerization of N-isopropyl acrylamide (NIPAM) onto cellulosic materials. The presence of thermo-responsive grafts at the surface of the nanowhiskers is expected to induce new properties such as colloidal stability at high ionic strength, surface activity, and thermally triggered dispersion and aggregation in aqueous media.

CNCs were synthesized from pre-treated ramie (Boehmeria nivea) fibres by appropriate hydrolytic fractionation in concentrated sulfuric acid.

Preliminary experiments conducted onto microcrystalline cellulose allowed us to compare the efficiency of various radiation-grafting methodologies. The so-called pre-irradiation process in aerated proved to be superior, allowing for the formation of surface peroxides that can be activated on-demand by the Fenton reaction in a subsequent grafting stage.

The grafting procedure was successfully applied to ramie CNCs. The effects of pre-irradiation dose, Mohr?s salt concentration, temperature, polymerization time and NIPAM concentration were investigated in details. Chemical and structural features of starting and modified CNCs were determined using a variety of analytical, spectroscopic and near-field imaging techniques (AFM) supporting good control of NIPAM graft polymerization.

The LCST behavior of poly(NIPAM) grafts induces réversible aggregation evidenced by dynamic light-scattering expriments.

FIGURES

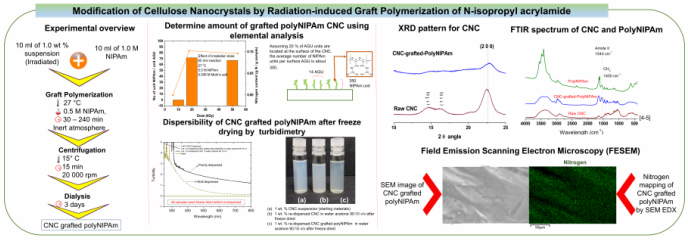

FIGURE 1

Overview of radiation grafting process

Radiation grafting and characterization of poly(NIPAM)-grafted cellulose nanocrystals

FIGURE 2

KEYWORDS

Cellulose nanocrystals | Radiation grafting | Stimuli responsive polymers | poly(NIPAM)

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