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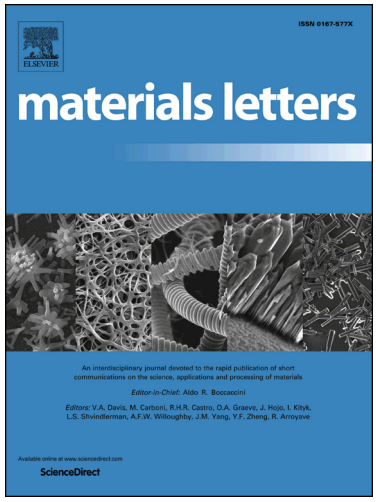

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Sodium alginate conversion into char via pyrolysis at the onset temperature

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Abstract
Pyrolysis is the simplest method to convert bio-based materials into carbonaceous chars. In this study, Na alginate (an aquatic-derived substance isolated from brown algae) is thermally treated under very mild condition (onset temperature). The effectiveness of the conversion has been determined via physicochemical characterizations, showing the possibility of modifying the (bio)polymeric chemical structure just at the beginning of its thermal degradation, guaranteeing an overall energetic beneficial effect.

Keywords: Carbon materials; Materials science; Na alginate; Natural products valorization; Pyrolysis; Thermal analysis.

1. Introduction

In order to reduce the consumption of fossil fuels, the valorization of natural products as alternative feedstock for the production of useful materials (in accordance to the green chemistry principles) is becoming a very promising research field [1-3]. Interestingly, the exploitation of aquatic-derived substances as possible raw materials is one of the most appealing technological solutions, especially considering that the majority of our planet surface belongs to the hydrosphere [4].
Aquatic-derived substances comprise a large variety of biomasses from animal (residues from (shell)fish and other (in)vertebrates) and vegetable (aquatic plants and algae) origin [5]. In this context, alginates are a class of polysaccharides extractable from brown microalgae. These biopolymers are composed by two monomeric units, i.e., β-D-mannuronic acid (M) and α-L-guluronic acid (G), organized in either homo- or hetero-polymeric sequences [6]. This class of bio-based materials is widely used in biomedicine as hydrocolloids (in particular with calcium).
According to the literature, several studies are focused on the production of carbonaceous materials from alginates [7-9]. As suggested by the *International Biochar Initiative* (IBI), temperatures commonly selected for pyrolysis are higher than 700°C [10], whereas milder conditions (below 550°C) are usually preferred in hydrothermal conversions [11]. In our recent studies [12-13], chitin (another aqueous-derived substance forming the crustaceans' shells), municipal biowaste derived humic-like substances and nanosponges from β-cyclodextrins were converted into biochar via pyrolysis carried out under mild conditions (in the range comprises between the onset temperature and 550°C). The main advantage of performing controlled pyrolysis at low temperatures is twofold: from the chemical viewpoint, it is possible to maintain some residual functionalities exploitable for particular applications (e.g., adsorption of polar substrates) [14], while, from the energetic viewpoint, lower temperatures require lower consumption of energy.
In the present work, we investigated the effects induced by thermal treatment on sodium alginate (derived from brown algae) at the beginning of the degradation phenomenon (onset temperature), alone and in presence of zinc chloride (catalyst).

2. Materials and methods

2.1. Reagents and chemicals