Innovative and sustainable materials for cross-sector applications in building constructions: preparation, synthesis, characterisation and industrial formulations

Abstract

Among the materials of interest in the construction field polyvinyl ethers are particularly notable. This class of polymer is widely used in adhesive formulations, where they are mixed with resins as well as in coatings for metals and plastics, and in antifouling paints. Furthermore, polymer properties can be customised according to the structure of the starting monomers. Polyvinyl ether monomers are produced industrially by reacting an alcohol with gaseous acetylene in a basic environment in an autoclave. The project focuses on the production of polyvinyl ether monomers to make their synthesis easier and more sustainable. In order to achieve this aim, it is necessary to produce vinyl ethers from bio-based substrates and using a safer acetylene source. In recent years, the use of CaC_2 as a reactant has been emerging, since the hydration reaction of carbide produces acetylene, which can be generated in situ in the reaction environment. This allows the synthesis of vinyl ethers under atmospheric pressure conditions, thus avoiding the use and transport of high pressurized acetylene.
This project focuses on the use of bio-based phenolic substrates derived from lignin depolymerization, including guaiacol, vanillin, eugenol, and resorcinol. These substrates represent a class of molecules that are expected to be produced in the future by second-generation biorefineries. The use of aromatic molecules in the project also allows further progress in the research of advanced materials, as it enables coupling reactions through Friedel-Crafts-type reactions of aromatic nuclei with carbonyl functionalities in an acidic environment. This allows the creation of monomer units containing more vinyl ethers moiety, enabling the synthesis of cross-linked polymers. In addition, another reaction that can be employed to produce monomers for cross-linked polyvinyl ethers formation is the oxidative coupling of guaiacol with $FeCl_3$. This reaction yields a trimerized aromatic core, which can then be functionalized to create a tri-vinyl ether.
By leveraging these approaches, this research aims to expand the possibilities for the sustainable production and advanced applications of polyvinyl ethers.

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