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Towards carbon fibers from single component kraft lignin systems: An application of green chemistry with forest biomaterials



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Carbon fibers represent a class of materials with enormous potential for many material and other engineering applications for our society. There are projections that by 2020 the actual demand for carbon fibers will be such that the traditional poly-acrylonitrile precursors used today will not be enough to address the projected demand. Consequently, it is imperative that new precursors based on the foundations of green chemistry need to be developed. In this respect technical, lignin presents us with formidable challenges, but also with enormous opportunities and they are to be explored in detail during this presentation. In our earlier effort, we have embarked in describing and discussing the importance of propargylation chemistry on lignin to synthesize lignin macromonomers for thermal polymerization via Claisen rearrangement. We have also discussed that the molecular weight and glass transition temperatures of the thermally polymerized lignin improves significantly relative to the starting material. The intricate polymer structure created within lignin because of the benzopyran double bond thermal polymerization chemistry is offering a regular covalently linked framework from which, after carbonization, a regular carbon fiber material could. As such, thermally polymerized propargylated softwood lignin emerges as a prospective material for the synthesis of bio-based carbon fiber precursor.

Various reactivity considerations that are to be discussed in the presentation were addressed by a series of experiments where initially acetone soluble kraft lignin (ASKL) was propargylated, thus occupying all readily accessible and highly reactive phenolic-OHs, followed by methylation of the remaining phenolic OH's to limit phenoxy radical induced thermal polymerization. All the polymerization reactions were conducted by heating the samples at 180°C for three hours and the corresponding molecular weights and distributions were determined. As anticipated, the installation of the propargyl groups in more reactive positions, more readily prone to Claisen rearrangement and thermal polymerization events, offered much better developed molecular weights able to offer carbon fibers.

Biography

Dimitris S Argyropoulos is a Professor of Chemistry at North Carolina State University and is internationally recognized for his leading contributions to green chemistry using wood biopolymers. His work focuses at promoting our understanding of the structure and reactivity of lignin and the development of novel NMR and material science techniques for the structural elucidation and the upgrading of these biopolymers representing otherwise unsolved, intractable problems in lignin-based material's chemistry. The efforts of his research group have been disseminated more than 200 scientific papers, numerous scientific conferences and invited presentations.

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