Innovative and sustainable materials for cross-sector applications: Preparation, synthesis, characterization and industrial formulation

Abstract

Synthetic polymers such as plastics, coatings and adhesives are now widely used in various aspects of everyday life, showcasing the versatility and practicality of this class of materials.[1] Nowadays there is a growing need for *bio-based* polymeric materials and innovative, sustainable and safe for human health synthetic methods for the production of polymer building blocks.[2] Furthermore, valuing industrial wastes, such as lignin derivatives from wood processing or furan and chitin derivatives from the food supply chain, is another issue to be addressed to promote a circular economy and the transition towards a more environmental-friendly industrial production of essential materials and commodities.[3]

Therefore, the aim of my research project is to develop advanced *green* synthetic techniques based on organic electrosynthesis, photocatalysis and flow-chemistry technologies. These are relatively unexplored fields of synthetic chemistry that are gaining a renewed interest for large-scale industrial applications due to their efficiency in performing useful redox and radical reactions with higher atom economy and lower energy expenditure than established methods, since they use light or electricity as the driving force instead of oxidizing or reducing agents or radical initiators.[4]

Useful reactions in the field of polymer chemistry are Ar-Ar cross-couplings, that are employed to prepare diaryl compounds bearing chiral axis. Some classic examples are Kumada, Negishi and Stille cross-couplings, which involve the use of Grignard, Nickel and haloaromatic compounds, respectively, hence they produce significant amount of waste byproducts.[5] Electrochemical Ar-Ar cross-couplings counterparts perform the same transformations with greater atom economy, since they are radical processes that use electricity instead of the aforementioned polluting chemicals to initiate the radical chain process.[6] Electrochemical Ar-Ar cross-couplings can be used to obtain diaryl cores from lignin phenolic derivatives having alkene groups that will be oxidized afterwards to obtain building blocks for epoxy resins. A *green* oxidizer for this oxidation is peroxodicarbonate, whose technical limitations lie in its low stability and short half-time, especially in concentrated solutions. Continuous-flow electrosynthesis may solve this issue: peroxodicarbonate is generated in a circular flow reactor from a carbonate solution and then used as for the ex-cell oxidation process of the core, yielding a fully *bio-based* epoxy resins.[7]

References

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