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A chemo-enzymatic CO2 capture process by ionic liquid technology

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PURPOSE OF THE ABSTRACT

The reduction of the CO2 concentration in the atmosphere is one of the main global challenges of this century , that requires the development of technological solutions for CO2 capture, and its conversion into added-value products. In the same context of Sustainable Development, the substitution of recalcitrant plastics (e.g. polyurethanes produces a serious ecological threats, etc.) for bio-based and biodegradable polymeric materials fulfilling circular economy criteria (e.g. water-based non-isocyanate polyurethane, etc) is another global challenge.[1] Glycerol is a renewable chemical from biomass of great interest because of its large availability as a by-product of the biodiesel industry, which can be used as a raw material in the synthesis of numerous products (e.g. polymers, solvents, fuel additives, etc.). Among its derivatives, glycerol carbonate (GC), resulting from the net incorporation of a carbon dioxide molecule to glycerol, is a versatile molecule, which can also be modified by introducing other reactive moieties (e.g. acrylate groups) to produce new functionalized monomers for polymer chemistry.[2]

A sustainable chemo-enzymatic process for producing both glycerol carbonate acrylate (GCA) and glycerol carbonate methacrylate (GCMA), as useful monomers for preparation of biodegradable plastic materials, has been carried out taking advantage of the ionic liquids (ILs) technologies.[3] The process consisted in two consecutive catalytic steps, which can be carried out by either sequential or one-pot experimental approaches. The glycidyl (meth)acrylate was firstly synthesized by enzymatic transesterification from (meth)acrylate vinyl ester with glycidol in Sponge Like Ionic Liquids (SLILs) as the reaction medium (100% yield after 6 h at 60 ºC). SLILs not only provided a suitable reaction medium but also allowed the simple isolation of the resulting glycidyl esters as an IL-free pure fraction through a cooling / centrifugation straightforward protocol. The second step consisted in the GCA, or GCMA, synthesis as the outcome of the cycloaddition of CO2 to the obtained glycidyl acrylate or

glycidyl methacrylate, respectively, catalysed by a covalently attached 1-decyl-2-methylimidazolium moiety (Supported Ionic Liquids-Like Phase, SILLP) in a solvent-free system and under mild conditions (60 ºC, 1-10 bar), leading to up to 100 % yield after 6 h. The components of the reaction system (biocatalyst/SLIL/SILLP) can be fully recovered and reused for at least 6 cycles with unchanged catalytic performance (see Fig. 1).[4] This technology has also been successfully used for the synthesis of other cyclic glycerol carbonate derivatives. The combination of both ILs and (bio)catalyst technologies can pave a new sustainable way to contribute to the reduction of the CO2 concentration in the atmosphere through its capture and incorporation into added-value products of interest..

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FIGURES

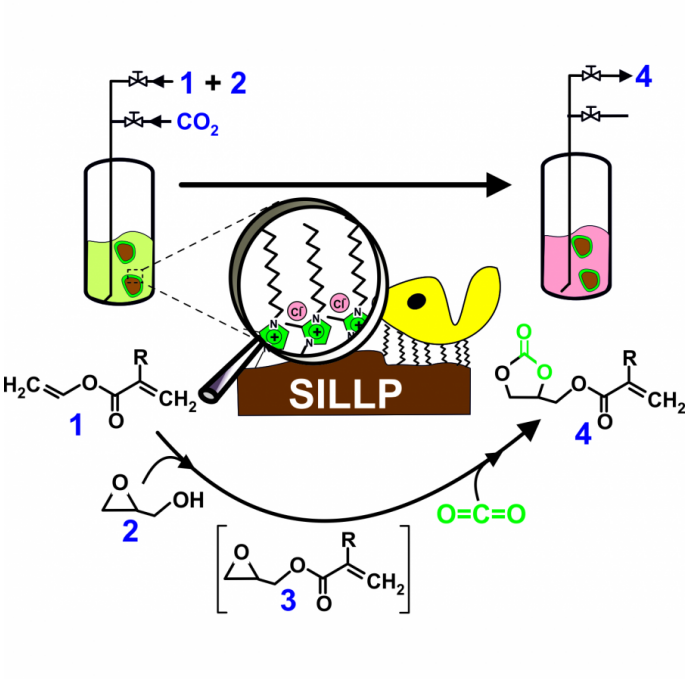

FIGURE 1

Figure 1

Schema of the one-pot chemo-enzymatic synthesis of GCA under solvent-free conditions, catalyzed through two consecutive reactions carried out by immobilized CALB onto 1-alkyl-3-methylimidazolium-based SILLPs, as a dual catalyst

FIGURE 2

KEYWORDS

lipase | ionic liquids | co2 capture | chemo-enzymatic process

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