NON-ISOCYANATE POLYURETHANE CHEMISTRY AND MULTIFUNCTIONAL BIO-INSPIRED POLYHYDROXYURETHANES

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The quest for green and sustainable plastics is stimulating the development of isocyanate- and phosgene free routes to polyurethanes exploiting both biological and chemical fixation of carbon dioxide. Particularly, polyfunctional cyclic carbonates, readily available by carbonatization of bio-based polyols and epoxides, represent highly versatile intermediates for non-isocyanate polyhydroxyurethanes (NIPU). In our process starting from the same raw bio-based raw material such as limonene dioxide and bio-based glycidylethers carbonatization with carbon dioxide affords multifunctional cyclic carbonates, whereas amination with ammonia produces the corresponding bio-based amine curing agents [3]. The incorporation of limonene dicarbonate derived from orange peels substantially improves NIPU stiffness [4]. For the first time NIPU formulations and rapid cure enable the fabrication of flexible NIPU foams [5]. The amine cure of carbonated POSS epoxy resins produces a new family of NIPU hybrid materials for scratch resistant coatings [6]. Going well beyond conventional polyurethane chemistry, the polyaddition of erythritol dicarbonate and sorbitol tricarbionate enables to produce linear, branched and crosslinked poly(carbohydrate-urethanes) at ambient temperatures without using protective groups [7]. The prospect of NIPU chemistry ranges from engineering plastics and thermoplastic elastomers to a great variety of tailor-made functional polyhdyroxyurethane materials including biocompatible materials for biomedical applications, triple-shape memory NIPUs [8], nacre-like NIPU, and new polymeric systems for 3D and 4D printing. This presentation gives an overview on the basic structure property correlations and new approaches toward the development of bio-inspired NIPU materials.

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