

Technology Offer

Organotextile Catalysis

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An easy process for the facile and permanent immobilization of organocatalysts on nylon textiles was developed. All of the prepared textile-immobilized organocatalysts (a Lewis basic, a Brønsted acidic, and a chiral organocatalyst) display excellent stability, activity and recyclability for various organic transformations. Very good enantioselectivity (>95:5 enantiomeric ratio) can be maintained for more than 250 cycles of asymmetric catalysis. The flexible construction of fabrics allows reactor constructions of arbitrary geometry and a quick removal of the catalyst.

Background

Organocatalysts are metal-free small molecules that display Lewis acidic or basic and Brønsted acidic or basic reactivity. Despite fruitful advancements in academia, further application of organocatalysts in industry is often hampered by their relatively low turnover efficiency.

The immobilization of organocatalysts via a covalent bonding interaction could provide a general solution, preventing leaching out of catalytically active centers.

To access heterogeneous organo-catalysts, research has focused on immobilizing the catalysts on diverse solid materials. However, a general and convenient method for the immobilization of different types of organocatalysts that addresses stability, reactivity, and recyclability of the obtained heterogeneous material has not been established previously.

Technology

A novel process for the facile and permanent immobilization of organocatalysts on the textile nylon using ultraviolet light was developed. The catalyst and the textile material require no chemical modification for the immobilization.

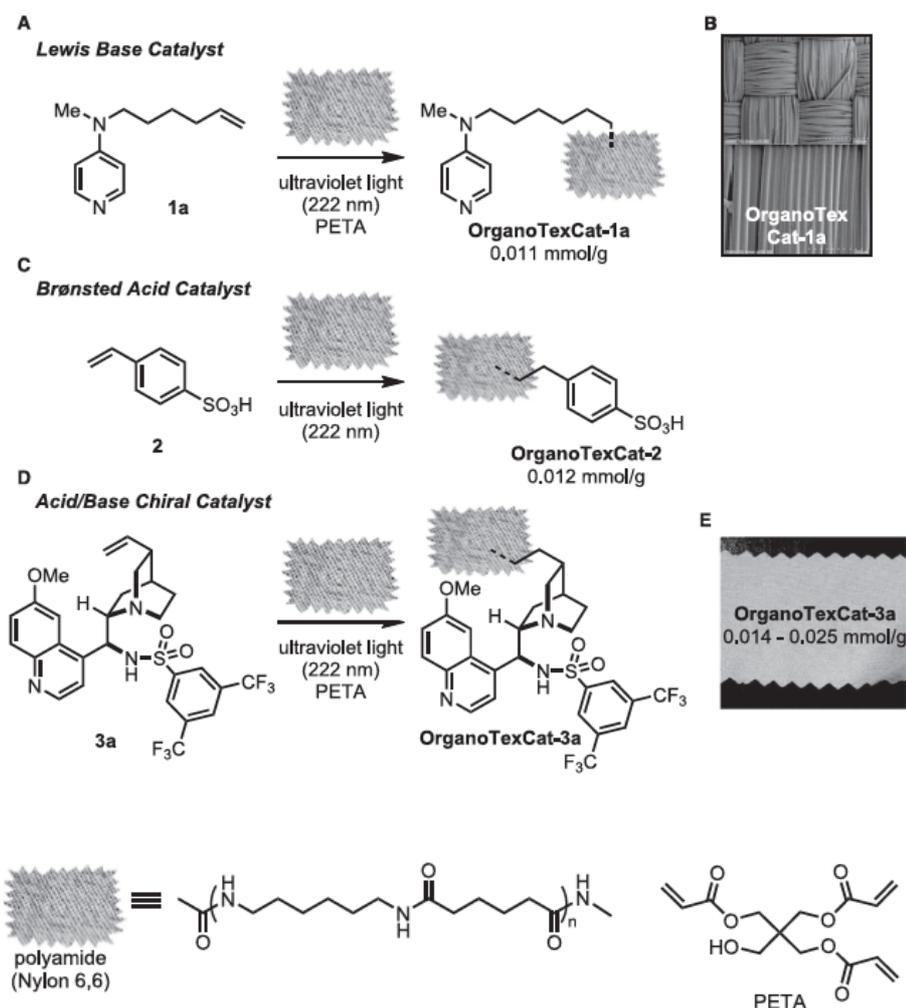


Fig. 1. Reaction conditions for the photochemical immobilization. The textile was irradiated with ultraviolet light for 5 min on each side of the textile wetted by a solution of the organic catalyst.

(A) Immobilization of DMAP derivative 1a on textile from an acetonitrile solution.

(B) Scanning electron microscope image of OrganoTexCat-1a.

(C) Immobilization of p-styrenesulfonic acid (2) on textile from a water/ethanol (1:1) solution.

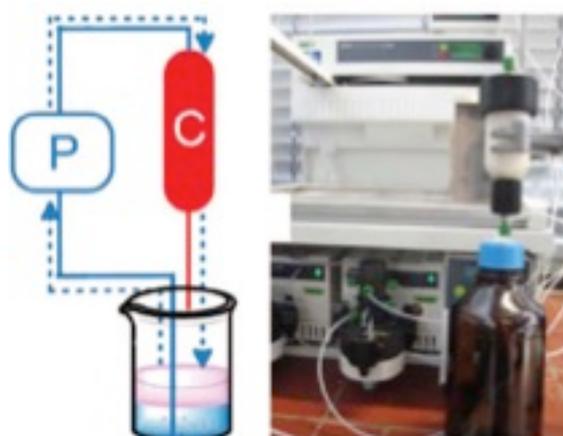
(D) Immobilization of bifunctional chiral catalyst 3 on textile from an acetonitrile solution.

(E) A photograph of catalyst OrganoTexCat-3a

Compared with polymer films, textile fibers exhibit a much higher surface area. The inherent capillary action of textiles allows an easy and uniform wetting of the material with the catalyst before the photoinduced immobilization. This leads to a uniform three-dimensional coating. As the active surface area is easily adjustable by varying the fiber diameter, the preparation of organotextiles with significantly higher catalyst loadings is also possible.

All of the prepared textile-immobilized organocatalysts (a Lewis basic, a Brønsted acidic, and a chiral organocatalyst) display excellent stability, activity and recyclability for various organic transformations. Very good enantioselectivity (>95:5 enantiomeric ratio) can be maintained for more than 250 cycles of asymmetric catalysis.

The flexible construction of fabrics allows reactor constructions of arbitrary geometry and a quick removal of the catalyst. For example, using a flow reactor with an Organo TexCat packed column in, an iterative continuous reaction is possible. The column is prepared without any sophisticated packing procedure, contrary to powder- or resin-based heterogeneous catalysts. The textile material showed good absorption ability for organic solvents, which can facilitate mass transfer onto the material, generating a microfluidic environment via capillary action to increase the effective catalyst concentration.



Literature

J.-W. Lee, T. Mayer-Gall, K. Opwis, C.E. Song, J.S. Gutmann, B. List: "Organotextile catalysis"; *Science* 341, 1225 (2013)

Th. Mayer-Gall, J.-W. Lee, K. Opwis, B. List, J.S. Gutmann: "Textile Catalysts - An unconventional approach towards heterogeneous catalysis", *ChemCatChem* 2016, 8, 1428–1436

Patent Information

EP patent application filed in May 2012. WO2013178640 filed in May 2013, nationalized in EP, US, JP, KR, IN, IL. JP6270826B2 granted.

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