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Magnetic Nanoparticles As a Solid Phase for N-Heterocyclic Carbene Based Catalysts

Iwona Misztalewska, Agnieszka Z. Wilczewska
University of Bialystok, Institute of Chemistry, ul. Hurtowa 1, 15-399 Bialystok, Poland
i.misztalewska@uwb.edu.pl, agawilcz@uwb.edu.pl

Extended Abstract

The design of efficient and reusable heterogeneous catalysts is an important target in organic chemistry. One strategy is to use a solid phase of high surface area to volume ratio as a support of the catalyst. This way high number of accessible active groups can be introduced on its surface. Recently, magnetic nanoparticles (MNP) have gained great attention as a magnetically separable matrix for catalysts (Baig and Varma, 2013; Ranganath and Glorius, 2011). Primarily, it is due to the superparamagnetic properties which allow for their easy separation from reaction mixture by putting an external magnetic field and therefore, allow them to be reused.

In our group we developed two ways of immobilization of catalyst on the surface of magnetic nanoparticles. One of them is "grafting from" approach which enables formation of the catalyst directly on the surface of MNP. This strategy was used for generation of magnetically separable imidazolinium salts (N-heterocyclic carbene precursor) from amine-terminated magnetic nanoparticles. Next, the MNP-NHC were used as ligands in the synthesis of magnetically separable NHC-Pd catalyst. The catalytic properties of nanoparticles-Pd complex were tested in the Heck cross-coupling reaction. In the majority of the studied reactions the catalyst allowed obtaining styrene derivatives in high yields. It was proven that the catalysts can be reused for several times without loss of its activity (Wilczewska and Misztalewska, 2014).

The second approach rely on using RAFT/MADIX polymerization in order to create of catalytically active polymeric shell around MNP. The MADIX polymerization is the type of a controlled radical polymerization which utilizes dithiocarbonates (xanthates) to mediate the polymerization via a reversible chain-transfer process. This polymerization technique allows for control of the chain growth and the polydispersity (Perrier and Takolpuckdee, 2005). Moreover, dithiocarbonates show a great tolerance towards most of the functional groups (Destarac, 2010). In our research, magnetic nanoparticles were initially covalently modified with xanthates and then, used to mediate the polymerization of various commercially available monomers. Additionally, new polymerizable imidazolium salt derivatives were synthesized and polymerized on the surface of xanthate-coated MNP. Furthermore, their catalytic activity towards benzoin condensation, Stetter and Heck reactions will be investigated.

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