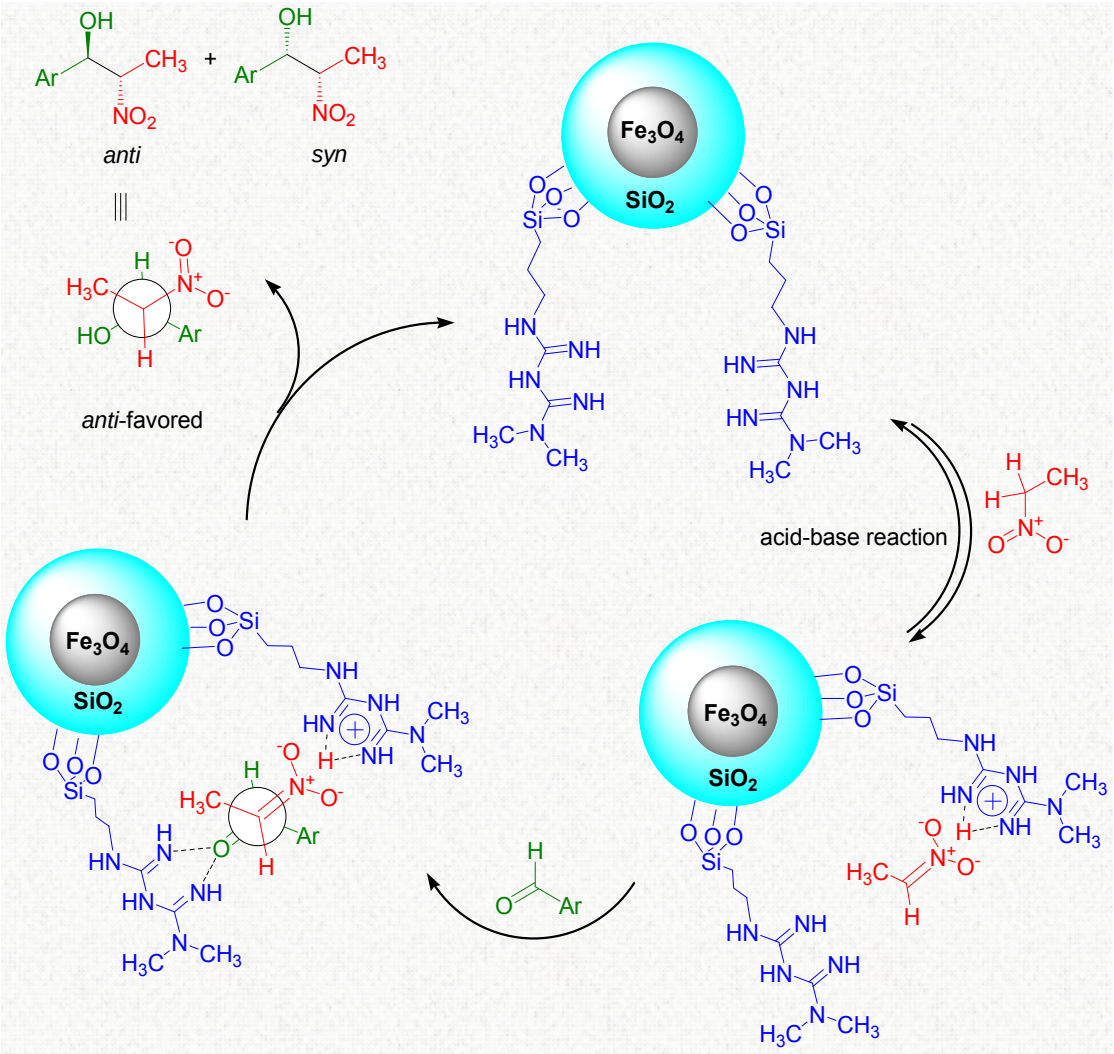
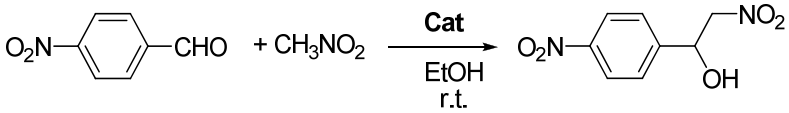


Scheme 2. Proposed catalytic cycle for the diastereoselective formation of *β*-nitroalcohols catalyzed by **Cat-2**.

Table 4. Yield of the model reaction with the recycling of **Cat-1** and **Cat-2**.



Run	Yield (%)[a]	
	Cat-1	**Cat-2**
1	98	97
2	97	96
3	96	96
4	93	95
5	91	93
6	70	92
7	63	92
8	58	88

[a]Isolated yield.

Conclusion

In summary, an organic superbase (*N,N*-dimethyl biguanide), immobilized on mesoporous silica SBA-15 and magnetically separable nanoparticle supports was found, for the first time, to act as efficient catalyst for the Henry reaction under mild conditions. Employing these new nanocatalysts, the reactions were carried out in fast (5-10 min), clean and cost-effective manner with possible reusability of the catalysts for several runs. Avoiding of organic volatile solvents and toxic catalysts enabled an operationally green new portal to *β*-nitroalcohols. In the case of magnetite support, ease in separation of the catalyst with an external magnet simply eliminates the filtration process and make the condition even greener. Additionally, there was a good stereoselectivity in the formation of *β*-nitroalcoholsobtained from the reaction of nitroethane with aldehyde which was believed due to the dual activation role of the catalyst.

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References

[1] F. Hoffmann, M. Cornelius, J. Morell, M. Fröba, Angew. Chem. Int. Ed. 45 (2006) 3216-3251.
[2] X. Dong, Y. Hui, S. Xie, P. Zhang, G. Zhou, Z. Xie, RSC Adv. 3 (2013) 3222-3226.
[3] Z. Tao, RSC Adv. 4 (2014) 18961-18980.
[4] N. Gao, Y.-L. Chen, Y.-H. He, Z. Guan, RSC Adv. 3 (2013) 16850-16856.
[5] L. Henry and C. R. Seances, Acad. Sci. 120(1895)1265-1268.
[6] A.P. Piccionello, P. Pierro, A. Accardo, S. Buscemi, A. Pace, RSC Adv. 3 (2013)24946-24951.
[7] Y. Zhang, Z.J. Li, H.S. Xu, Y. Zhang, W. Wang, RSC Adv. 1 (2011) 389-392.
[8] R. Ballini, G. Bosica, J. Org. Chem. 62 (1997) 425-427.
[9] Y. Wei, L. Yao, B. Zhang, W. He, S. Zhang, Tetrahedron 67 (2011) 8552-8558.
[10] L. Yao, Y. Wei, P. Wang, W. He, S. Zhang, Tetrahedron 68 (2012) 9119-9124.
[11] R. Ballini, D. Fiorini, M.V. Gil, A. Palmieri, Tetrahedron 60 (2004) 2799-2804.
[12] M.N. Elinson, A.I. Ilovaisky, V.M. Merkulova, F. Barba, B. Batanero, Tetrahedron 64 (2008) 5915-5919.
[13] R. Ballini, A. Palmieri, P. Righi, Tetrahedron 63 (2007) 12099-12121.
[14] J. Han, Y. Xu, Y. Su, X. She, X. Pan, Catal. Commun. 9 (2008) 2077-2079.
[15] T. Ishikawa, Superbases for organic synthesis: guanidines, amidines and phosphazenes and related organocatalysts, John Wiley & Sons, 2009.
[16] I. Kudyba, J. Raczko, Z. Urbańczyk-Lipkowska, J. Jurczak, Tetrahedron 60 (2004) 4807-4820.
[17] D. Simoni, R. Rondanin, M. Morini, R. Baruchello, F.P. Invidiata, Tetrahedron Lett. 41 (2000) 1607-1610.
[18] R. Mrówczyński, A. Nan, J. Liebscher, RSC Adv. 4 (2014) 5927-5952.
[19] Z. Zarnegar, J. Safari, RSC Adv. 4 (2014) 20932-20939.
[20] S. Shylesh, V. Schünemann, W.R. Thiel, Angew. Chem. Int. Ed. 49 (2010) 3428-3459.
[21] A. Hu, G.T. Yee, W. Lin, J. Am. Chem. Soc. 127 (2005) 12486-12487.
[22] V. Polshettiwar, R. Luque, A. Fihri, H. Zhu, M. Bouhrara, J.-M. Basset, Chem. Rev. 111 (2011) 3036-3075.
[23] A. Alizadeh, M. Khodaei, D. Kordestani, A. Fallah, M. Beygzadeh, Microporous Mesoporous Mater. 159 (2012) 9-16.
[24] A. Alizadeh, M. Khodaei, D. Kordestania, M. Beygzadeh, J. Mol. Catal. A: Chem. 372 (2013) 167-174.
[25] A. Alizadeh, M.M. Khodaei, M. Beygzadeh, D. Kordestani, M. Feyzi, Bull. Korean Chem. Soc. 33 (2012) 2547-2552.
[26] M. Beygzadeh, A. Alizadeh, M. Khodaei, D. Kordestani, Catal. Commun. 32 (2013) 86-91.
[27] N. Ono, The nitro group in organic synthesis, John Wiley & Sons, 2003.
[28] K. Dhahagani, J. Rajesh, R. Kannan, G. Rajagopal, Tetrahedron: Asymmetry 22 (2011) 857-865.
[29] Z.-L. Guo, S. Zhong, Y.-B. Li, G. Lu, Tetrahedron: Asymmetry 22 (2011) 238-245.
[30] X.-G. Liu, J.-J. Jiang, M. Shi, Tetrahedron: Asymmetry 18 (2007) 2773-2781.
[31] B. Subba Reddy, J. George, Tetrahedron: Asymmetry 22 (2011) 1169-1175.
[32] A. Cwik, A. Fuchs, Z. Hell, J.-M. Clacens, Tetrahedron 61 (2005) 4015-4021.
[33] V.J. Bulbule, V.H. Deshpande, S. Velu, A. Sudalai, S. Sivasankar, V. Sathe, Tetrahedron 55 (1999) 9325-9332.
[34] A. Noole, K. Lippur, A. Metsala, M. Lopp, T. Kanger, J. Org. Chem. 75 (2010) 1313-1316.
[35] L. Cheng, J. Dong, J. You, G. Gao, J. Lan, Chem. Eur. J. 16 (2010) 6761-6765.
[36] S. Selvakumar, D. Sivasankaran, V.K. Singh, Org. Biomol. Chem. 7 (2009) 3156-3162.