Metal-Free Carbon Nitride for the Continuous-Flow Vicinal Halotrifluoromethylation of Vinyl Compounds

Theodore A. Gazis[a], Gianvito Vilè[a]
[a]Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milano (Italy)
Presenting author e-mail address: theodorosantonis.gazis@polimi.it

Background and motivation. The trifluoromethyl group (-CF_3) is a core functionality in modern fine chemicals manufacturing.[1] Among various -CF_3 introduction strategies, the vicinal halotrifluoromethylation of alkenes is particularly attractive as it also installs a halide synthetic handle, allowing for the generation of extensive compound libraries. Current protocols typically involve harsh conditions, homogeneous catalysts and toxic reagents, making them unsustainable.[2] We developed a photocatalytic protocol based on recyclable carbon nitride (C_3N_4) to enable greener and scalable vicinal halotrifluoromethylation.

Materials and methods. Nanostructured C_3N_4 (mesoporous, bulk and nanosheet) was synthesized and fully characterized. Batch reactions were conducted to evaluate catalyst structure, -CF_3 source, reagent stoichiometries and irradiation wavelength. Continuous-flow packed-bed or structured reactor configurations (C_3N_4 and glass bead supports) proved the scalability and recyclability of the protocol.

Results and discussion. Batch optimization studies revealed mesoporous C_3N_4 delivered quantitative yields (4 h, CF_3SO_2Cl, visible light irradiation). Notably, no base was required unlike previous reports.[1] Time-on-stream analysis confirmed catalyst recyclability (5 cycles). The reaction was applied to 20 alkenes with diverse electronic and steric properties including bioactive cinchonidine. Finally, mechanistic and computational studies confirmed the photo-generated electron-hole pairs of C_3N_4 drive the reaction via a radical pathway.

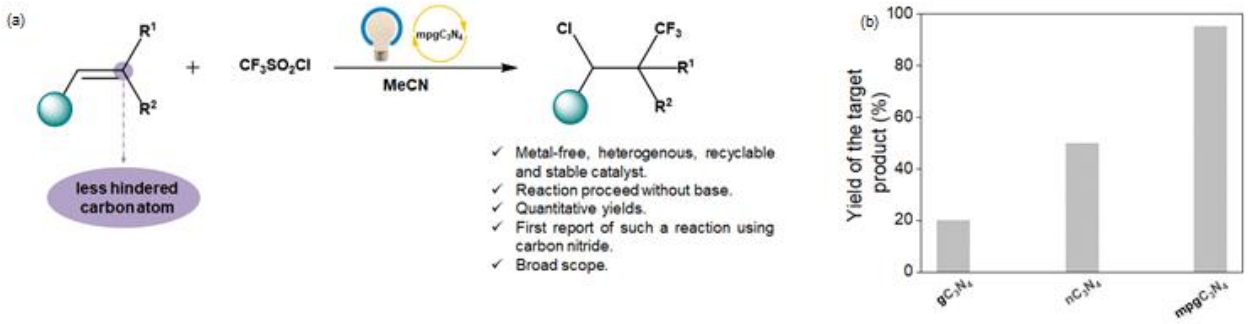

Figure 1: Reaction scheme (a), comparison of the performance of different nanostructured carbon nitride (b).

References

[1] N. Hura, A. Naaz, S. S. Prassanawar, S. K. Guchhait, D. Panda, *ACS Omega*., **2018**, *3*, 1955
[2] S. H. Oh, Y. R. Malpani, N. Ha, Y. S. Jung, S. B. Han, *Org Lett*., **2014**, *16*, 1310.