# Supported $\gamma$-$Fe_2O_3$ nanoparticles in CTF-1: A novel hybrid adsorbent for heavy metal sequestration

Jeffrey Paulo H. Perez[ab*] Karel Folens[a], Karen Leus[b], Maria Meledina[c], Marinela M. Dîrtu[d], Yann Garcia[d], Gustaaf Van Tendeloo[c], Pascal Van Der Voort[b] and Gijs Du Laing[a]

[a]*Laboratory of Analytical Chemistry and Applied Ecochemistry (ECOCHEM), Department of Applied Analytical and Physical Chemistry, Ghent University, Coupure Links 653, B-9000 Ghent, Belgium*
[b]*Center for Ordered Materials, Organometallics and Catalysis (COMOC), Department of Inorganic and Physical Chemistry, Ghent University, Krijgslaan 281-S3, B-9000 Ghent, Belgium*
[c]*Electron Microscopy for Materials Science (EMAT), Department of Physics, University of Antwerp, Groenenborgerlaan 171, 2020 Antwerp, Belgium*
[d]*Institute of Condensed Mater and Nanosciences, Molecules, Solids and Reactivity (IMCN/MOST), Université Catholique de Louvain, Place L. Pasteur 1, 1348 Louvain-la-Neuve, Belgium*

In this study, we present a novel hybrid material using the triazine-based Covalent Organic Framework, CTF-1, as a support for $\gamma$-$Fe_2O_3$ nanoparticles synthesized *in situ*. This novel hybrid material harnesses both the high reactivity and selectivity of nanoparticles and the versatile structural properties and high specific surface area of microporous materials. The resulting $\gamma$-$Fe_2O_3$/CTF-1 was investigated by $N_2$ sorption, XRPD, Mössbauer spectroscopy and various high-resolution TEM techniques such as HRTEM, HAADF-STEM, EDXS and STEM-EELS. It was examined in the recovery of critical and precious metals and in the removal of heavy metals. The performance of $\gamma$-$Fe_2O_3$/CTF-1 in the recovery of critical metals is significantly higher and unprecedented in comparison to other Fe-based sorbents and even their surface-functionalized analogues. $\gamma$-$Fe_2O_3$/CTF-1 also exhibited remarkable maximum Hg saturation uptake that is comparable to benchmark adsorbents. The $\gamma$-$Fe_2O_3$/CTF-1 material also demonstrated fast and efficient removal of Hg from water, selectivity for Hg species in the presence of competing species and remarkable stability and recyclability. These highlight the potential of $\gamma$-$Fe_2O_3$/CTF-1 as a promising hybrid nanomaterial for water treatment technologies.

* Current address: Section 4.4 Interface Geochemistry, Helmholtz Center Potsdam - GFZ German Research Center for Geosciences, Telegrafenberg, Potsdam 14473, Germany. Email: jpperez@gfz-potsdam.de