Design and synthesis of new magnetic composites for water purification

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Magnetic nanoparticles are very useful in various branches of industry including catalysis and liquid purifications. However, they are generally very sensitive to oxidation and agglomeration. Therefore, it is necessary to develop efficient strategies in order to improve their chemical stability and performance. Metal-organic frameworks (MOFs) are a new class of crystalline porous materials, which are made by stitching organic and inorganic molecular building blocks into extended frameworks using strong bonds. Every component of their structure can be varied and functionalized to optimize their chemical and adsorption properties. In addition, their pores sizes can be controlled on the angstrom level. Hence, we believe that MOFs are the best candidate to develop the chemistry of magnetic nanoparticles. The purpose of this proposal is to address the synergistic combination of functionalized magnetic nanoparticles and well-defined crystalline frameworks with high porosity for water purification. This includes the removal of organic and inorganic pollutants. We propose a post-synthetic preparation of nanoparticles in MOFs and surface coating of nanoparticles with MOFs. By using these approaches, MOF components will be synthesized using specifically designed linkers with tailored functionalities to stabilize and functionalize nanoparticles in MOFs. Chelating units such as thiol, amino, carboxylate, and crown ether moieties will be employed to selectively capture heavy and toxic metals and metal ions. Furthermore, the semiconductor behavior of some designed MOFs and the porosity of the composites will be used to photocatalytically remove organic pollutants. This proposed two-year project will be implemented at AUB. The MOFs and the composites synthesis, as well as the separation and purification studies will be performed at the chemistry department. We are confident that by combining the properties of MOFs with the features of magnetic nanoparticles, new purification systems with high performance can be elaborated.