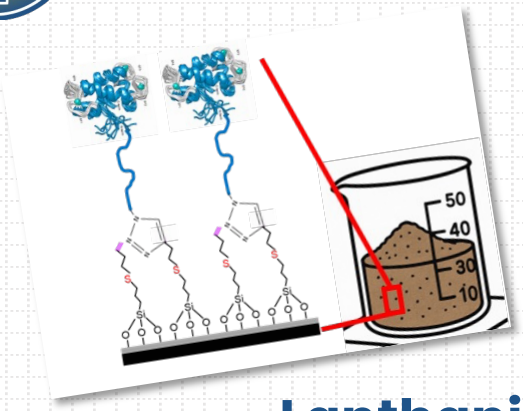
PhD DEFENSE



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Lanthanides extraction with material functionalized with a protein having a high affinity and selectivity

Wednesday, December 9, 2026

2:00 PM

Auditorium ICSM

Solid-liquid extraction is a promising method for recovering *f*-block elements contained in effluents from various industrial sectors. The objectives of this work were to prepare inorganic oxide supports functionalized with lanmoduline a protein exhibiting remarkable extraction and selectivity of block *f* elements, to determine whether these properties were maintained upon grafting the protein onto various supports, and to determine their efficiency. To achieve this aim, an innovative method was developed to avoid the protein purification step. This method involves pre-functionalizing the supports with alkyne groups suited for of reacting with azido-modified lanmodulin via "click" chemistry. Many supports have been used such as silicon substrates and naturally mesoporous silica such as diatomaceous earth, as well as pure inorganic oxides such as SiO_2, Al_2O_3, and ZrO_2. Using reflectometry and X-ray and neutron scattering techniques, the various functionalization steps as well as the reactivity of the grafted lanmodulin were investigated. The results show homogeneous grafting of the protein at a density of 1 lanmodulin/7 nm^2 as well as preservation of its reactivity. The results for the powders indicated a probable absence of functionalization by the protein in pores smaller than 10 nm, with a density on the order of 1 lanmoduline per 15 nm to 26 nm. Finally, extraction-dextraction tests using an $NdCl_3$ solution in the presence of a competing ion, as well as a model leachate from an NdFeB magnet, demonstrated the efficiency and selectivity of the lanmodulin-functionalized inorganic oxide powder supports. This work offers significant prospects for the preparation of protein-functionalized solid supports for element recovery.

Keywords: Solid-liquid extraction; Lanmodulin; Inorganic oxides; Functionalization; X-ray and neutron reflectometry; X-ray and neutron scattering



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