Unique surface complexation of lanthanide with phosphate and its development for phosphate recovery from sediment and water

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Excessive internal phosphate (P) presented in sediments is the essential problem causing eutrophication of lake for decades, as a consequence of iron reduction under anaerobic conditions. In this work, advanced spectroscopic technologies, inlcuding extended X-ray absorption spectroscopy (EXAFS), attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR), together with theoretic calculation (i.e. Density theory function) were combined to identify the surface complexation structure of La with P under different conditions, such as pH, and different P loadings, supporting the development of La-based materials for P recovery.

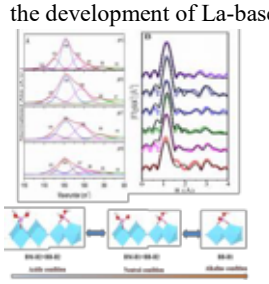

Fig.1 (a) ATR-FTIR spectra of phosphate on $La(OH)_3$ under different pH conditions; (b) EXAFS spectra of P K-edge of La loaded phosphate under different pH conditions; (c) proposed phosphate complex model on $La(OH)_3$.

The results showed that surface complexation was the primary mechanism for phosphate removal and in binary phosphate configurations, namely diprotonated bidentate mononuclear (BM-H2) and bidentate binuclear (BB-H2), coexisting on $La(OH)_3$ in acidic conditions. By increasing the pH to 7, BM-H1 and BB-H2 governed phosphate adsorption on $La(OH)_3$, whereas BB-H1 was the dominant configuration of phosphate adsorption at pH 9. The results were also finely verified by the surface complexation model. Finally, a novel $La(OH)_3/Fe_3O_4$ composite was developed for phosphate recovery with a capacity of 52 mg-P/g. Despite a slight inteference from sediment particles, this composite signficantly increases the phopshate sequestration/recovery in/from sediment by six times. This study provides a new direct for eutrophication control and phospahte recovery.[1]

[1].Fang, L.; Shi, Q.; Nguyen, J.; Wu, B.; Wang, Z.; Lo, I. M. C. Environ Sci Technol 2017, 51 (21), 12377-12384.