Structural alteration of iron oxides of Manganese substitution and potential application for Pb(II) removal

X.C. LU, H. LIU, M. LI, R. ZHANG[1]

[1]State Key Lab for Mineral Deposit Researches, School of Earth Sciences and Engineering, Nanjing University, Nanjing, Jiangsu Province 210023, China (xcljun@nju.edu.cn)

Natural goethite (α-FeOOH) commonly accommodates considerable trace elements such as Mn, Al substituting Fe. Such substitution greatly alters the structure and surface reactivity of goethite to a certain extent, which further affects its adsorption behavior of heavy metals. Compared to other substituting elements, Mn is much more interesting since its highest affinity with Fe.

In this work, Mn substituted goethites were synthesized and were characterized using multiple microscopic and spectroscopic techniques. The incorporated Mn, mainly presenting as Mn(III), causes the unit cell parameters of a and c diminishing while b increasing due to the Jahn-Tell effect of $Mn(III)O_6$ octahedral. With the Mn content increasing, the Fe-O(H) vibrations at 890.29 and 795.55 cm^{-1}, and Fe-O vibration at 642.7 cm^{-1} in FTIR spectra exhibit a linearly blue shift and red shift respectively, and the Raman intensity ratio at 386 cm^{-1} and 400 cm^{-1} decreases linearly. The decrease of particle size and occurrence of zigzag surface with Mn substitution lead to increases of specific surface area (SSA), and to gradual increase in Pb^{2+} adsorption capacity significantly. Besides the SSA effects, the enhanced surface charge of Mn-goethite favors high Pb^{2+} adsorptive performance. And the Mn-goethite shows great potential in material development for environmental remediation.

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