

The influence of SiO_3^{2-} on the reductive reactivity of Fe(II) adsorbed onto $\gamma\text{-Al}_2\text{O}_3$

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Iron in minerals and soil solution influence soil genesis and properties, as well as the transformation of contaminants. Whereas silica, aluminum and iron is the 2nd, the 3rd and the 4th most abundant element in the Earth's crust, respectively. Using electrochemical method and Fe *K*-edge X-ray absorption, this study was aimed at elucidating the role of surface-complex Fe(II) on $\gamma\text{-Al}_2\text{O}_3$ under different SiO_3^{2-} concentrations in the reductive transformation of 2-nitrophenol (2-NP). The adsorption kinetic studies showed that chemical adsorption is the rate limiting step in the Fe(II) and SiO_3^{2-} adsorption process. Furthermore, the addition of SiO_3^{2-} would decrease the density of adsorbed Fe(II) ($Q_{\text{Fe(II)}}$), as well as prevent the reductive transformation rate of 2-NP (k) by increase the activation energy (E_a) of the reaction. Moreover, positive linear correlation exist between $Q_{\text{Fe(II)}}$ and $\ln k$ of 2-NP, whereas negative linear correlation exist between the peak oxidation potential (E_p) of surface-complex Fe(II) and $\ln k$ of 2-NP by use of cyclic voltammetry (CV). Fe *K*-edge X-ray absorption was applied to characterize the surface-complex Fe(II) under various conditions at beamline 17C1 at the National Synchrotron Radiation Research Center at Hsinchu, Taiwan. The Linear Combination Fitting (LCF) results confirmed that with the increase of SiO_3^{2-} concentration, the composition of surface-complex Fe(II) would gradually change from pure $\square\text{AlOFe}^+$ ($\gamma\text{-Al}_2\text{O}_3$ surface-bound Fe(II) species) to mixture of $\square\text{AlOFe}^+$ and $\square\text{SiOFe}^+$ (SiO_2 surface-bound Fe(II) species), leading to the decrease of $Q_{\text{Fe(II)}}$, positive shift of E_p , further decrease k value of 2-NP reduction.

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