Evidence for tetrahedral AlO₄ formation induced by Zn²⁺ adsorption onto Al(OH)₃ gel

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HIGHLIGHTS

- The presence of AlO₄ species was found on Al(OH)₃ with adsorbed Zn²⁺.
- Zn–Al hydroxide coprecipitate with a zinc aluminate-like structure was formed.
- Surface complexation alone is not sufficient to explain heavy metal behavior.

GRAPHICAL ABSTRACT

Zn₂⁺ adsorption onto Al(OH)₃ gel induces Al³⁺ dissolution followed by the coprecipitation of Al³⁺ with Zn²⁺ to form AlO₄ tetrahedral structures on the surface of Al(OH)₃ gel.

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ABSTRACT

27Al magic-angle spinning nuclear magnetic resonance (MAS NMR) spectroscopy was used to investigate the effect of Zn²⁺ ion adsorption on Al(OH)₃ gel. While as-prepared Al(OH)₃ gel exhibits a single peak around 5 ppm, the same gel with adsorbed Zn²⁺ has new peaks around 15 and 60 ppm. These peaks correspond to AlO₆ octahedral species with adsorbed Zn²⁺ and AlO₄ tetrahedral species, respectively. In order to assess the mechanism for the formation of AlO₄ tetrahedral species, hydroxide coprecipitates of Al³⁺ and Zn²⁺ were prepared and the chemical states of Al in the solids were observed by 27Al MAS NMR. The coprecipitates were found to have the AlO₄ tetrahedral structure, except for those with high Zn/Al ratios. From these results, it can be assumed that adsorption of Zn²⁺ onto Al(OH)₃ gel induces Al³⁺ dissolution followed by the coprecipitation of Al³⁺ with Zn²⁺ to form AlO₄ tetrahedral structures on the surface of Al(OH)₃ gel.

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