

Adsorption and hydrolysis of Au(III) on the surface of δ -MnO₂ and Al₂O₃

DAISUKE KAWAMOTO^{1*} AND AKANE MIYAZAKI¹

¹Faculty of Science, Japan Women's University, 2-8-1 Mejirodai, Bunkyo-ku, Tokyo, Japan

* e-mail: kawamotod@fc.jwu.ac.jp

Adsorption of dissolved Au(III) complex ions onto metal oxides plays an important role in transport of gold in hydrosphere. To elucidate the adsorption behavior, studies has been conducted between Au(III) complex ions and metal oxides. Our previous study revealed that one of the driving force for the adsorption was hydrolysis of the dissolved Au(III) complex ion [1]. Moreover, the adsorbed Au(III) complex ion was found to reduce spontaneously to Au(0) on the metal oxides surface. However, details of the hydrolysis and the reduction of Au(III) are still unclear. In this study, we aimed to elucidate detailed adsorption mechanism of Au(III) complex ion on metal oxides.

Adsorption experiments were performed at 20°C in ambient air by adding HAuCl₄ powder into 1 g/dm³ suspension of δ -MnO₂ or Al₂O₃. These suspensions were previously equilibrated to the air by stirring magnetically in the air for 24 hours. The amount of the HAuCl₄ powder was adjusted so to the concentration of Au in the resulted solution be 0.1 mmol/dm³. At adequate interval, aliquots of the suspension were taken out and filtered with 0.20 μ m membrane filter. The concentrations of Cl⁻ and Au were measured by anion exchange chromatography and ICP-AES, respectively. The concentration of H⁺ was measured by glass electrode equipped with a pH meter after the measurement for the concentration of Cl⁻. The same experiment but without oxide was also conducted as a control experiment.

Adsorption behavior of Au(III) complex ions onto δ -MnO₂ and Al₂O₃ showed clear differences. While all of Au(III) complex ions adsorbed onto δ -MnO₂ within 30 min, the adsorption onto Al₂O₃ took more than 72 h. Kinetic analysis revealed that the adsorption process onto δ -MnO₂ followed pseudo-first order rate equation, but the adsorption onto Al₂O₃ was not pseudo-first order reaction. The analysis of Cl⁻ and H⁺ for the control experiment without oxide suggested that all the HAuCl₄ powder dissolved within 2 min and 3.10 mol of Cl⁻ was released from 1 mol of Au. This means the average coordination number of Cl to Au(III), Cl/Au, was 0.90. This Cl/Au ratio did not change for the whole experimental period of 72 h. In contrast, the existence of oxide affected the coordination of Cl/Au ratio. In the δ -MnO₂ suspension solution, Cl/Au ratio gradually decreased from 1.78 to 0. This means Cl⁻ release from Au(III) complex ions accompanied with Au(III) complex ions adsorption onto δ -MnO₂.

[1] D. Kawamoto et al., Goldschmidt 2017.