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Fixed-point SEM observations of acidic dissolution mechanism of galena surfaces

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Acid mine drainage (AMD) is one of the major worldwide environmental problem associated with the mining of metal sulfide deposits (e.g. Deer et al., 1992). Recently, numerous dissolution experiments with galena have been carried out using its powder samples (e.g. Hsieh and Huang, 1989). They do not correctly reflect natural environment where galena occurs as massive ore bodies. Taking into consideration the structural characteristics on the mineral surface, in situ surface analysis techniques with AFM and STM have been used to examine the forms of etch pits created on the surfaces during dissolution experiments (e.g. Higgins and Hamers, 1996; De Giudici and Zuddas. 2001). However, the effect of chemical zoning on the dissolution features can not be clarified with these techniques. Since SEM equipped with EDS provides information both of local deformation and chemical composition on the mineral surfaces, it is very available for the surface analysis in dissolution experiments. In this study, we established the method of fixed point SEM observation and we applied it to the analysis of galena crystal surface etching in acid solution.

The specimen used is natural galena crystal from the Kamioka mine, central Japan. For the SEM observation, we selected a soluble aluminum metal as a coating metal because the coating metal on the surface can be removed during a dissolution experiment. Crystal approximately 0.2 $*$0.2 $*$0.2 mm in size was fixed with carbon tape to slide glass and then it was immersed in 500 ml vessel of 1.0 mol/l HCl aqueous solution. The reactive vessel was put into a thermostatic water bath maintained at 300 K. The experimental process is divided into three parts: coat the surface on the sample with aluminum, investigate the form of surface using SEM, and dissolve the surface of the sample in acid solution. The cycle was repeated to investigate the crystal surface features of galena during its dissolution process.

The results show that dissolution occurs by generation of the formation of square-shaped etch pits with edges parallel to [110] directions, which is consistent with a previous study using STM analysis (Higgins and Hamers, 1996). The authors described that the square etch pit orientated along [110] directions were attributed to the different dissolution rate between [110] and [100]. In this study, we could find numerous diamond-shaped etch pits on the crystal surfaces. We conclude that the chemical etching of galena crystal surface is initiated by cracks occurred mainly by cleavage parallel to [100] directions, which is followed by the dissolution of the corners faced with cleavage. The cleavage occurred in acid solution results in the diamond-shape of etch pits observed on the galena surface.