

Dissolution of gibbsite: Direct observations using fluid cell atomic force microscopy

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ABSTRACT

In situ atomic force microscopy (AFM) was used to follow the far-from-equilibrium dissolution of the {001} cleavage surface of natural gibbsite in nitric acid. The main dissolution mechanism was the retreat of straight monolayer steps, the edges of which are parallel to the <110>, <010>, and <100> directions. The stability of these steps can be expressed as <110> > <010> > <100>. The results are explained in terms of the positions of the terminal O atoms and their associated Al atoms at the steps. New steps were formed at etch pits that opened where screw dislocations emerged on the surface. The dissolution rates were calculated from the change in size of pits and islands. The values obtained were $9.5 \times 10^{-9} - 2.3 \times 10^{-8}$ mol/m²-s, normalized to the total surface area, and $1.8 - 3.6 \times 10^{-7}$ mol/m²-s, normalized to the surface area of the step fronts. The rates of dissolution calculated using only the surface area of the step fronts are similar to literature values obtained by other methods.