Investigating Calcite Growth Rates Using a Quartz Crystal Microbalance with Dissipation (QCM-D)

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The growth rates and mechanisms of calcite under close to equilibrium conditions are still not well understood. In this study, a quartz crystal microbalance with dissipation (QCM-D) was used for the first time to measure macroscopic calcite growth rates under close to equilibrium conditions. The results demonstrated that the growth rates measured by QCM-D were similar with those measured using atomic force microscope (AFM) though discrepancies still existed. The discrepancies in growth rates among AFM, QCM-D measurements, and model predictions appear to mainly arise from differences in step densities. Whereas the step velocities were consistent among those AFM, QCM-D measurements, as well as with both model predictions. These may be resulted from different generation and pretreatment processes for calcite seed crystals, which created different initial step densities on the calcite crystals. This indicated that the initial hillock step densities need a much longer time than step velocity to reach a steady state under current solution condition. The step densities transition process from initial pretreatment solution to current solution condition were measured using vertical scanning interferometry (VSI). This study provides valuable insights into the effects of reactive site densities on calcite growth rate.