

Determination of layer stacking microstructures and intralayer transition of illite polytypes by high-resolution transmission electron microscopy (HRTEM)

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ABSTRACT

A detailed investigation of microstructures of authigenic illite has been carried out using high-resolution TEM. Near-atomic images of $1M$ and $2M_1$ polytypes of illite with incidence $[100]$ and $[110]$ were observed. We unambiguously determine $1M$ illite in both individual particles and microtwinning domains. Newly formed $2M_1$ domains are surrounded by former packets of $1M_0$ or $1M$ illite. Such intergrowth of different illite-polytypic domains on a scale of several layers suggests that they are metastable. The lateral-coherent $1M$ and $2M_1$ illite domains are aligned along the same orientation and crystallographically continuous normal to $[001]^*$. This is a new phenomenon observed for polytypic intergrowth and transition. The intralayer-stepwise change of stagger direction in a series of successive layers and consequently the interlayer-stacking angle change resulting in polytypic transition are hypothesized as an “intralayer-stepwise transition” model. It explains the process of illite polytypic transition in the solid state.

Keywords: Illite polytype, HRTEM, microstructure, intralayer-stepwise transition