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Microstructural changes and deformation during the phase transformations in solid Ammonium Nitrate

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Abstract: Movie images were recorded with a polarised light microscope to examine the grain structures of a material undergoing phase transformations. The material, ammonium nitrate, was chosen simply because it has four stable crystal forms at temperatures below 170°C, and not because it is a direct analog of any rock forming mineral. Thin films of the material were made by melting small dry crystals between glass slides then solidifying. Displacive and reconstructive phase transformations were observed directly using polarised light with the ammonium nitrate heated to appropriate transformation temperatures. Reverse transformations were observed by cooling. Since the heater was a few centimetres from the parts of the specimen being viewed, thermal gradients existed and in addition some time was needed for temperatures to rise- both of these allowed the phase transformations to be recorded as they passed through the field of view. For the transformations between different phases, there was seen a range from slow migration of cuspate phase boundaries to 'martensitic' shear transformation involving near-instantaneous formation of very narrow lenses of the new phase. In some cases shear stress was applied using a modification of the well known FUTRONTM in-situ deformation apparatus and the stress was found to influence the transformation behaviour in a variety of ways. This type of analog approach, inspired by the pioneering work of Means in other systems, demonstrates some of the many ways that phase transformation and deformation processes could be interacting in response to stresses and to P, T, X, ... changes in the Earth and in our laboratories.

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