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X-ray Speckle Measurements of a Shape Memory Alloy in Training

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The deformation of most types of metals involves an irreversible flow of crystallographic dislocations. This allows for their ductility. The deformation of a metallic shape memory alloy (SMA), on the other hand, is accommodated by a solid-solid phase transition. If deformed in the low-temperature martensitic phase, an SMA can be returned to its original shape by raising its temperature to the point where it changes back to its high-temperature parent phase. When the reverse occurs and the transformation is from parent to martensitic phase, an SMA goes from a high-symmetry to a low-symmetry state in which a number of martensitic variants are produced. Using in situ X-ray Photon Correlation Spectroscopy (XPCS), we monitored the self-organization of martensitic variants in a CuAlNi SMA during thermal cycling. In high-angle scattering geometry, this technique uses correlation from X-ray speckle to quantify the degree of crystallographic change in a material. Our measurements revealed enhanced reversibility in the organization of the martensitic variants as the system became trained during repeated thermal cycling.

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