The first-order transition in magnetocaloric $LaFe_{11.8}Si_{1.2}$ probed by in-situ synchrotron XRD

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First-order transitions in magnetocaloric materials are the source of strong changes in their magnetization and entropy, giving rise to large magnetocaloric effects. These kind of transitions show interesting phenomena, like phase coexistence and thermal arrest. The way each phase nucleates from the other phase is largely unknown at a microscopic level, besides this being important not only from a fundamental point of view, but also for technical aspects like choosing the geometry of the sample or identifying an upper limit for the cycling frequency. In La(Fe,Si)13, an isostructural first-order transition occurs at the critical temperature TC, which retains the structural symmetry of the crystal but leads to an abrupt change in the lattice parameter. We apply low-temperature in situ X-ray diffraction on magnetocaloric La(Fe,Si)13 to study the magnetoelastic transition as a function of temperature. The in-situ XRD experiments have been carried out at the Petra III /2.1 beamline at DESY in Hamburg (Germany). With in-situ XRD and subsequent Rietveld refinement, the lattice parameter and the phase fraction of the two phases coexisting close to the critical temperature where identified in very fine temperature steps ($\Delta T = 0.05$ K). We identified how the phase transition evolves for the first and following cycles and found that there is a significant asymmetry in the width of the transition for the cooling and the warming process.

We will discuss these new features of the first-order transition in terms of their implications for the application of magnetocaloric materials.