Phase selection in Mn-Si alloys by fast solid-state reaction with enhanced skyrmion stability

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B20-type transition-metal silicides or germanides are noncentrosymmetric materials hosting magnetic skyrmions, which are promising information carriers in spintronic devices. The prerequisite is the preparation of thin films on technology-relevant substrates with magnetic skyrmions stabilized at a broad temperature and magnetic-field working window. The canonical example is the B20-MnSi film grown on Si substrates. However, the as-yet unavoidable contamination with MnSi1.7 occurs due to the lower nucleation temperature of this phase. In this work, we report a simple and efficient method to overcome this problem and prepare single-phase MnSi films on Si substrates. It is based on the millisecond reaction between metallic Mn and Si using flash lamp annealing (FLA). By controlling the FLA energy density, we can grow single-phase MnSi or MnSi1.7 or their mixture at will. Compared with bulk MnSi the prepared MnSi films show an increased Curie temperature of up to 41 K. In particular, the magnetic skyrmions are stable over a much wider temperature and magnetic-field range than reported previously. Our results constitute a novel phase selection approach for alloys and can help enhance specific functional properties such as enhancing the stability of magnetic skyrmions.