The effect of long-range order on thermal conductivity in cold-worked $Fe_{50}Pd_{50}$ alloys

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We report on the effect of long-range order on the thermal conductivity in heavily cold-worked $Fe_{50}Pd_{50}$ alloys. The deformed state of $Fe_{50}Pd_{50}$ brought on by cold-working is known to enhance the magnetic properties by a factor of two, relative to its non-deformed counterpart [1]. However, the deformation can complicate the growth, and the resulting microstructure, of the ferromagnetic $L1_0$ state [2]. In this work, we heavily cold-work a series of bulk FCC (A1) $Fe_{50}Pd_{50}$ alloys, and then nucleate the $L1_0$ phase by annealing at 500°C, well below the order-disorder temperature [3]. The long-range order parameter, or the percentage of the sample transformed to the $L1_0$ phase, is altered by annealing for different lengths of time. The resulting microstructure, coercive fields, and thermal conductivity are then measured. Transmission electron microscopy revealed the ordering transformation occurs simultaneously with recrystallization, which results in a decrease in the average grain diameter as long-range order is enhanced. The resulting impact on thermal conductivity is an immediate enhancement on thermal conductivity at even low degrees of long-range order, originating from a suppression in mass-impurity scattering. From intermediately to fully ordered, there is no additional enhancement in thermal conductivity, due to increased scattering from grain boundaries resulting from the recrystallization.

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