FERMI SURFACE RECONSTRUCTION IN THE SHAPE-MEMORY ALLOY AuZn


Introduction

AuZn undergoes a shape-memory transition at 67 K. Survival of the de Haas van Alphen effect to 100 K enables the observation of a Fermi surface reconstruction associated with the transformation. Coexistence of both Fermi surfaces at low temperatures is suggestive of an intrinsic, bulk phase separation.

Results and Discussion

The de Haas van Alphen (dHvA) measurements were performed on austenitic single crystal samples of stoichiometric AuZn using a highly compensated micro-coil magnetometer and a 65 T short-pulse magnet at the NHMFL, LANL.

Figure (a) above shows the Fourier-transform spectra of the data at 600 mK. Several distinct frequencies of dHvA oscillation are observed, one at around 1140 T and its second and third harmonics, and another at around 4660 T. (b) shows the 1140 T peak at two temperatures that straddle the phase transformation. This frequency is not present at 68 K, but only appears at temperatures below the transition, demonstrating that it is caused by orbits on the low-temperature, or martensite, Fermi surface. Conversely, (c) shows that the peak at 4660 T is present at 68 K implying that it is due to orbits on the high temperature, or austenite, Fermi surface. The amplitude of this frequency drops as the temperature is cooled below the transformation temperature. This is more clear in (d) which shows the temperature dependence of the amplitude of the 4660 T frequency. A sharp drop occurs at 66.5 K caused by a large part of the austenite transforming into the martensite phase and hence no longer being able to support this frequency of oscillation. The dotted lines in (d) are fits of the data to the Lifshitz-Kosevich formula for the amplitude of quantum oscillations. The effective masses taken from the fits to the high- and low-temperature data are found to be the same within the errors, the only difference between the fits arising from the volume of the sample contributing to the oscillations. The volume fraction of the austenite phase remaining below the transition is found to be 50% for the data in (d). Several experiments have been performed and the exact volume fraction is found to vary, probably due to slight changes in the stress on the sample associated with the method with which it is fixed into the measurement coil. Whatever the reason, the volume fraction never drops below about 20% even when the sample is completely free. The loss of austenite occurs abruptly at the transition temperature and there is no evidence of further reduction down to low temperatures. Thus it seems that a bulk phase separation of the austenite and martensite at low temperatures is an intrinsic property of the material.