# Determination of the Néel Temperature of Face-Centered-Cubic Iron

G. J. JOHANSON AND M. B. MCGIRR
*School of Metallurgy, The University of New South Wales, Kensington, New South Wales, Australia*

AND

D. A. WHEELER
*Australian Institute of Nuclear Science and Engineering, Lucas Heights, New South Wales, Australia*

(Received 11 September 1969)

The Néel temperature of face-centered-cubic iron precipitated in a copper single-crystal matrix has been determined by neutron diffraction as approximately 67°K. This disagrees with a previous determination of 8°K, but is in good agreement with a value of 60°K predicted by extrapolation of results obtained with iron-manganese alloys.

WHEN copper-iron alloys containing less than 4.5 at.% iron are aged, a coherent iron-rich (approximately 3 at.% copper) face-centered-cubic phase is precipitated.[1,2] Abrahams, Guttman, and Kasper[3] carried out a neutron-diffraction study of this precipitate and found it to be antiferromagnetic with a moment of 0.75 $\mu_B$ on the iron atoms. The specimens investigated were single crystals of composition 2.8 and 3.3 at.% iron solution treated in argon for 24 h at 1050°C, quenched to room temperature and then aged for 48 h at 700°C. The Néel temperature was estimated by Abrahams *et al.* as 8°K, from the Brillouin function which best fitted the temperature dependence of the structure factor in the range 1.43–4.63°K, using an $S$ value of $\frac{1}{2}$.

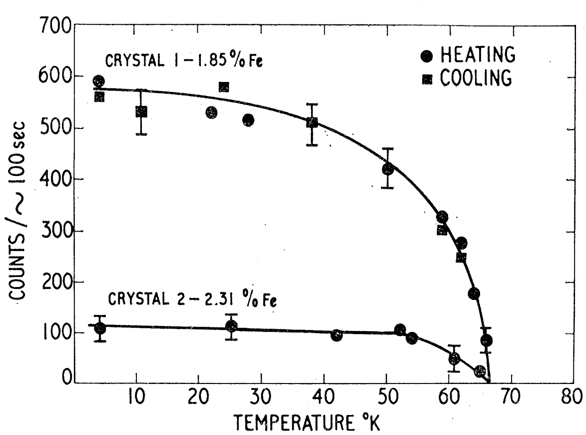


FIG. 1. Corrected neutron counts (relative to a fixed monitor count), at the peak of the (110) superlattice reflection. Error bars shown are typical.

We have measured the intensity of the most prominent magnetic superlattice reflection from 4.2°K to room temperature as part of a further investigation of the magnetic structure of the iron-rich precipitate. The specimens examined were large single crystals of the copper-iron alloy of composition 1.85 and 2.31 at.% iron, which have had the same heat treatment as that described above. Figure 1 shows the variation of count rate with temperature at the peak of the (110) superlattice reflection for each of the two crystals examined. The count rates are due to the (110) antiferromagnetic reflection from the iron-rich phase alone, having been corrected for background, and for the second-order reflection from the copper matrix. A Néel temperature of approximately 67°K is indicated.

This value agrees with the predicted value of approximately 60°K obtained for face-centered-cubic iron by extrapolating the Néel temperatures of a series of face-centered-cubic iron-manganese alloys to zero manganese content.[4] These values disagree with the value of 8°K found by Abrahams *et al.*; however, their quoted error in structure factor was of the same magnitude as the difference between the structure factors determined at the extreme temperatures. The observed variation in structure factor with temperature may thus have been due to a random fluctuation in count rate.

The authors wish to thank the Australian Institute of Nuclear Science and Engineering for supporting this project.

[1] J. B. Newkirk, Trans. AIME **209**, 1214 (1957).
[2] K. E. Easterling and H. M. Miekk-Oja, Acta Met. **15**, 1133 (1967).
[3] S. C. Abrahams, L. Guttman, and J. S. Kasper, Phys. Rev. **127**, 2052 (1962).
[4] L. M. Corliss, J. M. Hastings, and R. J. Weiss, J. Phys. Chem. Solids **25**, 183 (1964).