21 J. F. Harrod, S. Ciccone and J. Halpern, *Can. J. Chem.*, 1961, **39**, 1372
22 D. Sawyer, R. George, J. Bagger, *J. Amer. Chem. Soc.*, 1959, **81**, 5893
23 W. R. Crowell, D. M. Yost, *J. Amer. Chem. Soc.*, 1928, **50**, 374
24 R. E. Connick, D. A. Fine, *J. Amer. Chem. Soc.*, 1961, **83**, 3414
25 I. M. Rehn, A. S. Wilson, private communication
26 J. L. Howe, *J. Amer. Chem. Soc.*, 1927, **49**, 2393
27 N. K. Pshenitsyn, *Iv. Sektora Platiny ION. Kh. Akad. Nauk U.S.S.R.*, 1955 (33), 20–30 [*Anal. Abstr.*, 1957, 2214]
28 E. B. Sandell, Determination of Traces of Metals, 3rd ed., New York, Interscience, 1959
29 F. E. Beamish, W. A. E. McBryde, *Anal. Chim. Acta.*, 1958, **18**, 551
30 E. D. Marshall, R. R. Rickard, *Anal. Chem.*, 1950, **22**, 79
31 R. Larsen, L. Ross, *Anal. Chem.*, 1959, **31**, 1768
32 W. L. Below, G. R. Wilson, L. T. Corbin, *Anal. Chem.*, 1961, **33**, 886
33 J. H. W. Forsythe, R. J. Magee and C. L. Wilson, *Talanta*, 1960, **3**, 324
34 T. Hara, E. B. Sandell, *Anal. Chim. Acta.*, 1960, **23**, 65
35 A. K. Majumdar, J. G. Sen Gupta, *Z. Anal. Chem.*, 1961, **178**, 401
36 A. Brandostetr, *Coll. Czech. Chem. Comm.*, 1961, **26**, 392
37 D. L. Manning, O. Menis, *Anal. Chem.*, 1962, **34**, 94
38 J. E. Curran, A. Fischel, *Anal. Chem.*, 1952, **24**, 1980
39 G. H. Ayers, F. Young, *Anal. Chem.*, 1950, **22**, 1281
40 C. V. Banks, J. M. O'Laughlin, *Anal. Chem.*, 1957, **29**, 1412
41 A. M. G. MacDonald, *Ind. Chem.*, 1959, **35**, 293

Magnetic Transformations in Iron-Rhodium Alloys

ANOMALOUS CHANGES AT MODERATE TEMPERATURES

The saturation intensity of ferromagnetic materials generally decreases slightly with heating until at temperatures approaching the Curie point a rapid decline occurs. A notable exception to this rule is afforded by alloys containing approximately equal numbers of iron and rhodium atoms which are non-magnetic at room temperature and become suddenly ferromagnetic when heated to 60°C. Above this temperature they respond as normal ferromagnetic materials, the Curie point being at 400°C. Hocart and Fallot (1, 2) who first reported this behaviour attributed it to a sudden ordering reaction. Recent X-ray (3) and neutron-diffraction (4) measurements have shown that the magnetic transformation is due to a rapid yet uniform expansion of the CsCl type ordered structure which exists above and below critical temperature. The state below this temperature is antiferromagnetic with the magnetic unit cell doubled in all directions (5, 6). In the ferromagnetic region above the characteristic temperature the magnetic and crystallographic unit cells coincide.

A field of 5 Koe is sufficient to saturate the 52 atomic per cent rhodium alloy which has a peak magnetic intensity at 77°C of 115 emu/gm. (7). Rhodium has in this region an appreciable magnetic moment, and it is probable that the magnetic moment of the iron atoms in this alloy is higher than in alpha iron (6). The temperature hysteresis associated with the magnetic and electrical resistance changes of this alloy has been interpreted as evidence of a first order phase change (7). Complete confirmation of this hypothesis would require the demonstration of a crystallographically discrete phase.

The remarkable magnetic characteristics of the alloy are likely to be of considerable utility. Thermal switching is an obvious application, although more sophisticated devices will undoutedly suggest themselves to the development engineer.

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References

1 M. Fallot, *Ann. Phys.*, 1938, **10**, 291
2 M. Fallot and R. Hocart, *Rev. Sci.*, 1939, **77**, 498
3 F. de Bergevin and L. Muldawer, *Compt. rend.*, 1961, **252**, 1347
4 F. de Bergevin and L. Muldawer, *Bull. Amer. Phys. Soc.*, 1961, **6**, 159
5 E. F. Bertaut, A. Delapalme, F. Forrat, G. Roult, F. de Bergevin and R. Pauthenet, Proceedings of International Conference on Magnetism and Crystallography, 1961, vol. III. (*J. Phys. Soc. Japan*, 1962, **17**, Supplement B.III)
6 E. F. Bertaut, A. Delapalme, F. Forrat and G. Roult, F. de Bergevin and R. Pauthenet, *J. Applied Physics*, 1962, Supplement to Vol. 33, No. 3, 1123–1124
7 J. S. Kouvel and C. C. Hartelius, *J. Applied Physics*, 1962, Supplement to Vol. 33, No. 3, 1343–1344