

# Order-Disorder Transformations in some Iron-Nickel-Platinum Alloys

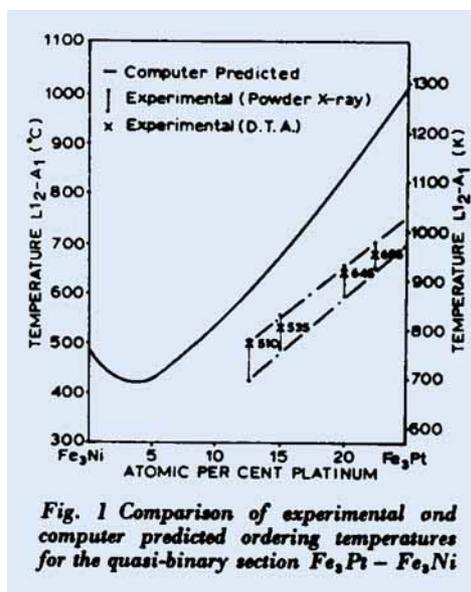
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Iron-platinum alloys have been extensively studied in recent years because of the shape memory effects that can be produced by suitable heat-treatment (1-3). Furthermore the formation of the thermoelastic martensites that underlie shape-memory effects seems to be linked to prior ordering in the parent austenite, and here iron-platinum alloys offer the possibility of varying this degree of order in a more systematic manner than most, if not all, other memory alloys investigated so far. One might have thought that iron-nickel alloys would be amenable to a similar treatment, since these two binary systems are analogous in so many ways; this turns out not to be the case, largely because ordering of bulk alloys at the analogous  $\text{Fe}_3\text{Ni}$  composition seems to be absent. However, ordering in iron-rich iron-nickel alloys has been reported for powdered alloys, foils, and irradiated specimens (4-6), suggesting that its absence in bulk material may only be due to lack of diffusion. Since there is no particular reason to expect vastly different diffusion coefficients in iron-nickel and iron-platinum alloys, and since the ternary system iron-nickel-platinum has not been extensively investigated, it is plainly of interest to test a series of alloys along the quasi-binary section  $\text{Fe}_3\text{Pt}-\text{Fe}_3\text{Ni}$  with a view to obtaining data about (a) kinetics, (b) ordering, and (c) the characteristics of the martensite transformation in this area. Such a programme has been jointly organised, under the Science Research Council's Co-operative Award in Science and Engineering scheme, between the University of Surrey and the Johnson Matthey Group Research Laboratories, and some preliminary results of interest are reported here.

The observed variation of ordering temperature in ternary alloys with nickel-platinum ratio, together with a computer prediction of the values expected from a ternary phase diagram prediction programme developed by Inden (7), is shown in Figure 1.

It can be seen that the ordering temperature, as determined by both X-ray and differential thermal analysis techniques, drops from the platinum rich end of the section more or less as predicted, bearing in mind that the computer prediction uses an idealised set of parameters. However, as the midpoint composition is approached, ordering becomes increasingly more sluggish, leading to the absence of experimental data for ordering temperatures on the nickel rich side of the quasi-binary section (Figures 1 to 4).



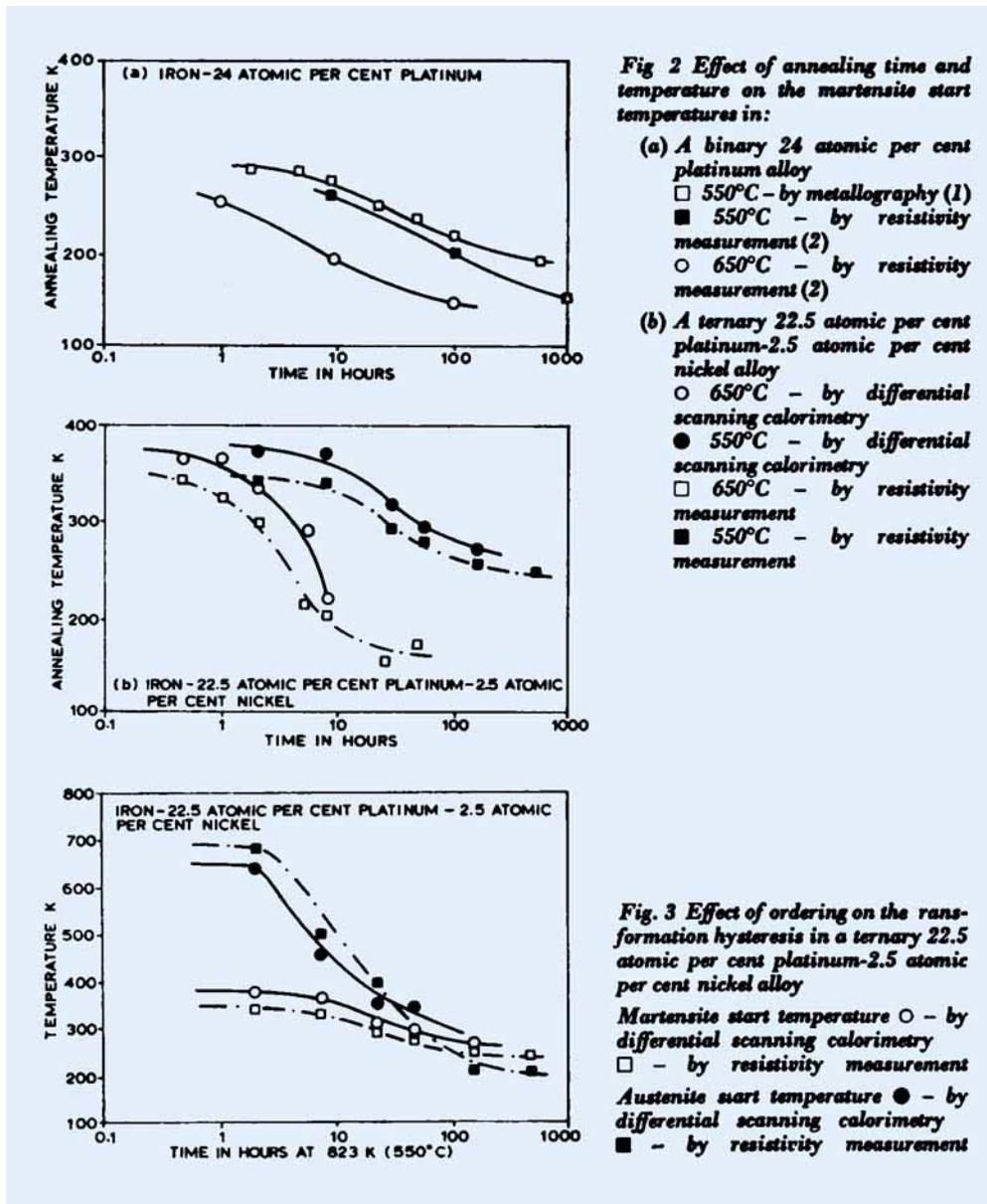


Fig 2 Effect of annealing time and temperature on the martensite start temperatures in:

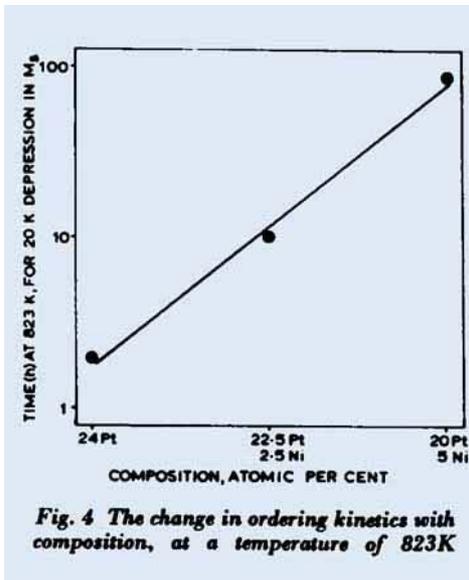
- (a) A binary 24 atomic per cent platinum alloy
  - 550°C - by metallography (1)
  - 550°C - by resistivity measurement (2)
  - 650°C - by resistivity measurement (2)
- (b) A ternary 22.5 atomic per cent platinum-2.5 atomic per cent nickel alloy
  - 650°C - by differential scanning calorimetry
  - 550°C - by differential scanning calorimetry
  - 650°C - by resistivity measurement
  - 550°C - by resistivity measurement

Fig 3 Effect of ordering on the transformation hysteresis in a ternary 22.5 atomic per cent platinum-2.5 atomic per cent nickel alloy

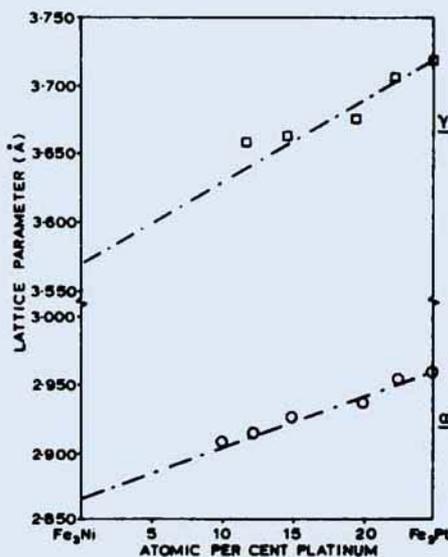
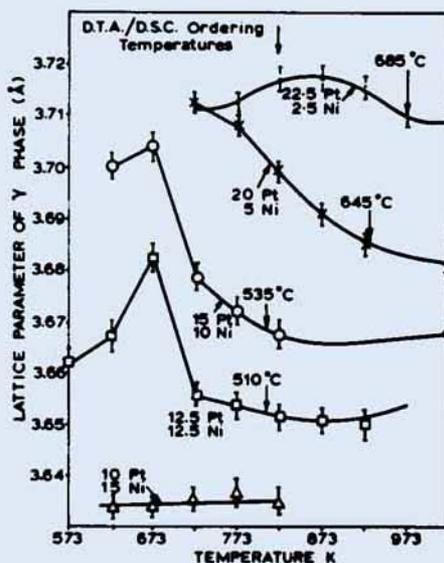
- Martensite start temperature ○ - by differential scanning calorimetry
- - by resistivity measurement
- Austenite start temperature ● - by differential scanning calorimetry
- - by resistivity measurement

This bears out the indications available in the literature concerning the effect of nickel, but it has not as yet proved possible to explain this change of behaviour. Figure 2 shows that at the platinum rich end of the system, an alloy containing 22.5 atomic per cent platinum and 2.5 atomic per cent nickel behaves very similarly to a 24 atomic per cent binary

iron-platinum alloy, as evidenced by the lowering of the martensitic start ( $M_s$ ) temperature with annealing time. Such a lowering of the  $M_s$  can be expected from ordering in the parent matrix, and should be accompanied by a sharp decrease in the hysteresis of the shear transformation, which is indeed borne out by the data in Figure 3.



However, with the addition of 5 atomic per cent nickel it is very clear that the onset of ordering has become very retarded (Figure 4) and by the time an alloy of composition 10 atomic per cent platinum and 15 atomic per cent nickel is reached, there is no indication of ordering from X-ray data (Figure 5). Although it is tempting to attribute this to lower diffusion rates, it can be seen from Figure 5 that marked changes in lattice parameter occur after annealing at lower temperatures in some of the more nickel rich alloys. For the present the only explanation of these anomalies—which are well outside the level of experimental error—is that there is some complex interplay between pre-ordering phenomena and the invar behaviour of this group of alloys (8-9). As far as the properties of disordered alloys are concerned, Figure 6 shows that there appear to be no great discontinuities across the section under investigation from the point of view of the lattice parameters of both austenite and martensite. Further work is in progress to relate the ordering behaviour with the invar effect before returning to the basic study of how these factors in turn affect the nature of the martensite transformation in this system.



## References

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# Patent Information on Catalytic Processes

**Hydrogenation Catalysts 1977** BY ROBERT J. PETERSON,

Noyes Data Corporation, Park Ridge, New Jersey, 1977, 324 pages, \$36

This book is a digest of the United States patents granted since 1970 on the subject of catalysts for hydrogenation processes. Shorn of legal phraseology, each entry describes concisely the essential features of the invention, usually with details of at least one or two examples. To those, not only academics, who pay scant regard to the patent literature, this book will come as an eye-opener: some 200 patents have been abstracted, and they represent a very substantial contribution of our knowledge of the practice of catalysis. Unfortunately there is no means of knowing whether this is all, or only a part, of what appeared in this period.

The arrangement of the subject-matter however calls for comment. The book under review serves the same function as a telephone directory, in the sense that few will wish to read it from cover to cover, while many may wish to seek information in it. For such a book, the logical arrangement of its contents is of paramount importance. The first two chapters concern catalyst preparation in general, while the following ones (which are not numbered) cover catalysts for hydro-refining, for hydrogenating aromatics, olefins, dienes, acetylenes, polymers, nitriles, nitro-compounds and "other materials". The drawback to this mode of presentation is that a method of preparing a catalyst is rarely specific to only one functional group. Thus the reader, desiring to acquaint himself with the present state of the art of making, say, palladium catalysts will have to search each and every chapter diligently for this information, since the book contains no subject index: this is a quite inexcusable omission, even although the table of contents is quite

detailed. In short the book is the repository of much useful information which is difficult to recall on demand. It is, as Bottom's speech, "like a tangled chain : nothing impaired but all disordered". However I do not wish to be unkind. It is a very interesting book, and I am pleased to have it on my bookshelf.

G. C. B.

## Fast Response Temperature Detector

A temperature measuring device which is capable of responding quickly to temperature changes, and which in addition is approved for use in some hazardous areas—including certain glass lined reaction vessels—incorporates a Pallaplat (rhodium-platinum versus palladium-gold) thermocouple which is compatible with the glass lining of the enclosing glassed-steel probe.

Recently announced (*Electronics W.*, 1977, (886), 10), the device brings together temperature detecting elements developed by Henry Balfour & Co. Limited of Leven, Fife, and intrinsically safe instrumentation provided by Measurement Technology Limited of Luton, Bedfordshire.

The temperature detecting element responds exponentially to temperature change and has a half-time of only about 2.5 seconds. As the temperature transmitter is considerably faster than this the whole unit is eminently suitable for responding rapidly to any variation from the temperature required in an automatically controlled process, or for activating alarms if the temperature of a product deviates from a critical level.