Solid-State Effects on Electrode Potential of Ni II: Enhancement of Effects on Hydrogenation of Cold Worked Samples

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Annealed nickel wires were subjected to cathodic hydrogen diffusion both with and without cold working. Cold worked wires show enhanced electrode potential after hydrogen diffusion compared to the simple annealed and hydrogenated wire.

In our earlier paper (1) the effects of cold work on the electrode potential of previously-annealed nickel wires was described. The effects though small were measurable and were classed as a kind of solid-state effect. The cold worked samples when left to themselves tried to regain their original properties. We now see that if the freshly cold worked samples are subjected to cathodic hydrogen diffusion till they are saturated and then left to outgass the diffused hydrogen, certain permanent changes in their electrode potential (e.p.) are observed.

EXPERIMENTAL

The method of annealing, cold work and e.p. measurements and cathodic hydrogen diffusion(2) are given earlier. Here we give only the sequence of experimentation :

1. Samples were vacuum annealed at 240, 290,425,600 and 750°C for 24 hours and then furnace cooled and electropolished.

2. Potential of each sample is measured against a saturated calomel electrode. This is given in the last row of table 1

3. A sample was taken out of the stock, annealed at a particular temperature and subjected to cathodic hydrogen diffusion for 200 hours in presence of thiourea. It was then left to outgas for 2 to 3 days. Again its potential was measured. This is given in the first row of table 1

4. Annealed samples were subjected to cold work 10, 15, 20, 25 and 30 times of winding unwinding cycles described earlier(1). Each of these were hydrogenated, outgassed and their potentials were measured. These results of presented in table 1.

RESULTS AND DISCUSSIONS

All the results obtained in the present investigations are presented in table 1. To compare these with our earlier(1) results of cold work above, we plot the variation of e.p. with no. of cold work cycles. Fig.1 shows the variation when the annealing temperature is 240°C. Continuous curve respresents the present results (first cold work then hydrogenation) while the dashed curve is the effect of hydrogenation alone. Results for samples annealed at 425° and 750°C are similar, but those for 290° (Fig.2) and 600°C are different ! . The effect of hydrogen diffusion on e.p. is just in the reverse direction compared to that due to cold work(1). Mention may be made here about an observation reported by Clarebrough et al(3).

TABLE 1

ELECTRODE POTENTIALS (mv) BEFORE AND AFTER HYDROGENATION OF DIFFERENTLY COLD WORK WIRES OF NICKEL.

No. of cycles of cold work	Annealing temperature °C					
	240	290	425	600	750	Unannealed
0	378	498	354	338	500	440
10	-	-	-	360	530	-
15	426	368	390	368	-	378
20	-	-	400	-	540	-
25	460	356	418	398	545	358
30	470	356	425	402	550	353
Initial EP	284	280	320	310	326	292

When annealing is done at 300°C and 600°C there is a release of strain energy in nickel. These very samples show a reverse behaviour in e.p. charges due to cold work but the effect of hydrogen diffusion remains similar to that observed in samples annealed at other temperatures. Formation of cracks, cavities etc. under hydrogen diffusion is well known(4). However cracks alone should not change the property of the material but trapping of hydrogen at lattice sites of the kind suggested by Birnbaum and Wert(5) can indeed alter the various solidstate properties.Thus a part of diff-

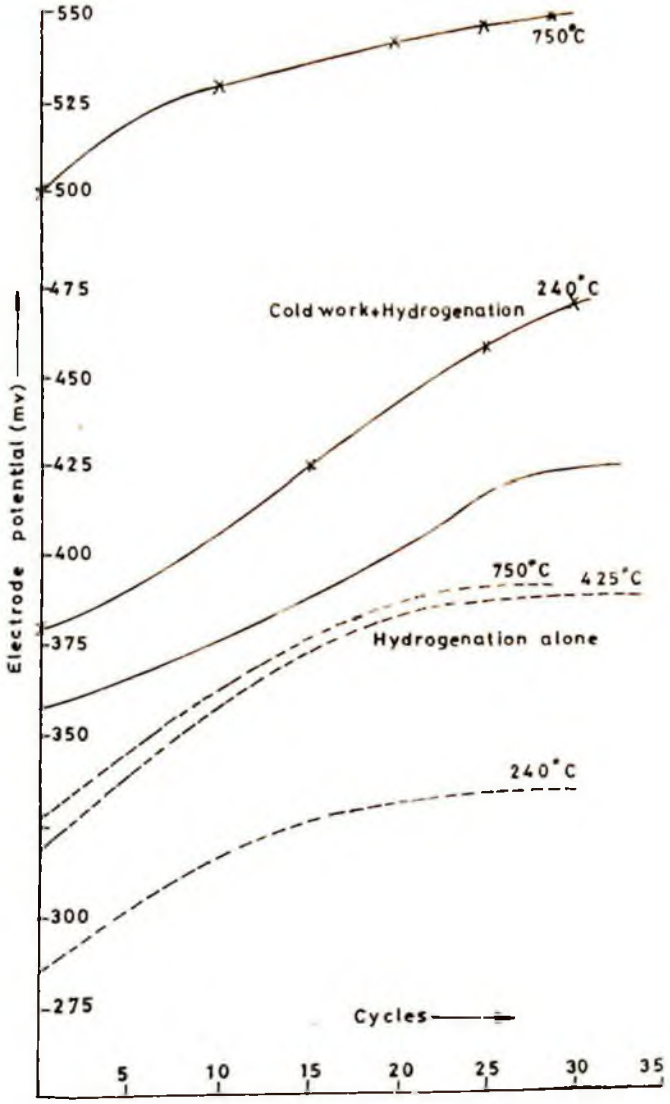


Fig. 1 Variation of electrode potential with number of hold works cycles at different unnealing temperatures.

used hydrogen remains in the lattice and is not given off during outgassing. This part of hydrogen will cause permanent changes in e.p. Since e.p. values are also dependent on the phase of the medium, it is evident that nickel has not the original phase after diffusion and subsequent outgassing of hydrogen. The changed phase depends also on the extent of cold work done in the annealed wires before hydrogen was diffused.

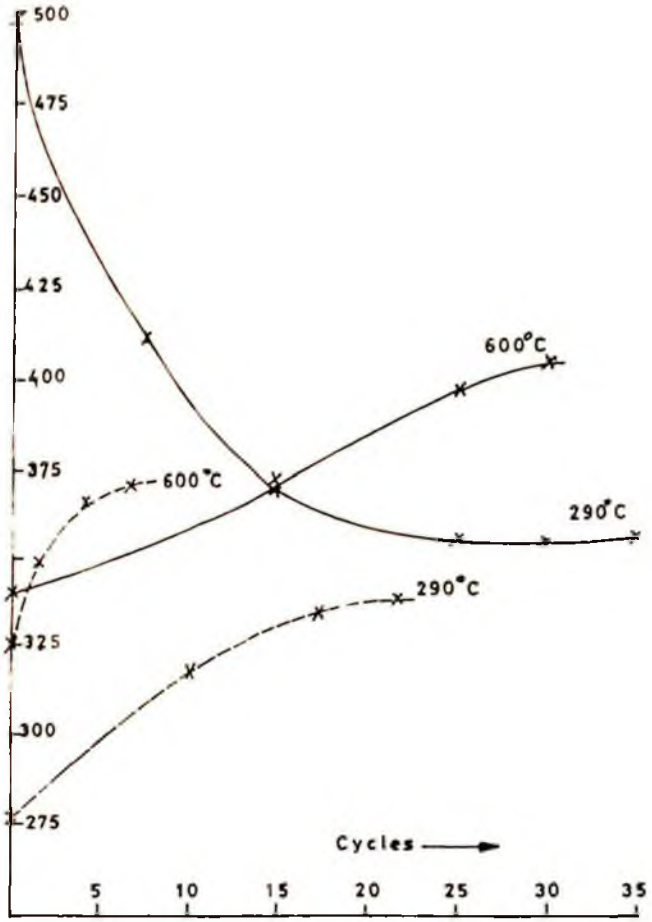


Fig. 2 Variation of electrode potential with number of hold works cycles at different unnealing temperatures.

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