Solid-State Effects in Electrode Potential of Ni - III: The Electrode Potential of Nickel Films Electrodeposited on Differently Annealed and Cold Worked Nickel Wires

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Nickel wire samples were first annealed, electropolished and then divided into two groups. One group was electroplated and e.p. measured. The other group was cold worked, then electroplated and gave different e.p. showing different crystal faces on the electrodeposit.

In an earlier paper(1) we described the effect of cold work on the electrode potential (e.p.) of nickel wires that were first annealed at different temperatures and then cold worked to different degrees. In such wires, the average orientation of different faces of microcrystallites at the surface will be different. If such a cold worked wire be now subjected to nickel plating the deposited layer will have still different orientations depending upon the substrate orientation(2) - and hence different e.p. from the substrate. It is shown in the present note that the variation in e.p. of the deposited layer with cold work differs with annealing condition.

EXPERIMENTAL

Nickel wires, 0.25mm diameter, 1 m length were sealed in glass/quartz capsules at 10^{-5} Torr vacuum and then annealed at 240, 290, 425, 600 and 750°C for 24 hours and then furnace cooled. The annealed samples were electropolished by Tomilson method (3). The e.p. of these in saturated solution of nickel sulphate wr to SCE is measured initially using a Toshniwal potentiometer model CL-106 A.

Samples annealed at each temperature were divided into two groups A and B. Group A was electroplated by nickel in a Watt's bath at a current of 30 mA supplied from a 6 V lead accumulator for 24 hrs and the thickness of the deposit determined by weighing the sample before and after electroplating. The average thickness was 26 micron. An e.p. measurement of the electroplated samples was made. Group B was subjected to cold work by winding unwinding method described earlier (1), their e.p. measured, then they were electroplated the same way as group A samples and again e.p. measured.

RESULTS AND DISCUSSIONS

Fig.1 shows the variation in e.p.of annealed samples before and after electroplating against the annealing temperature. The results for group

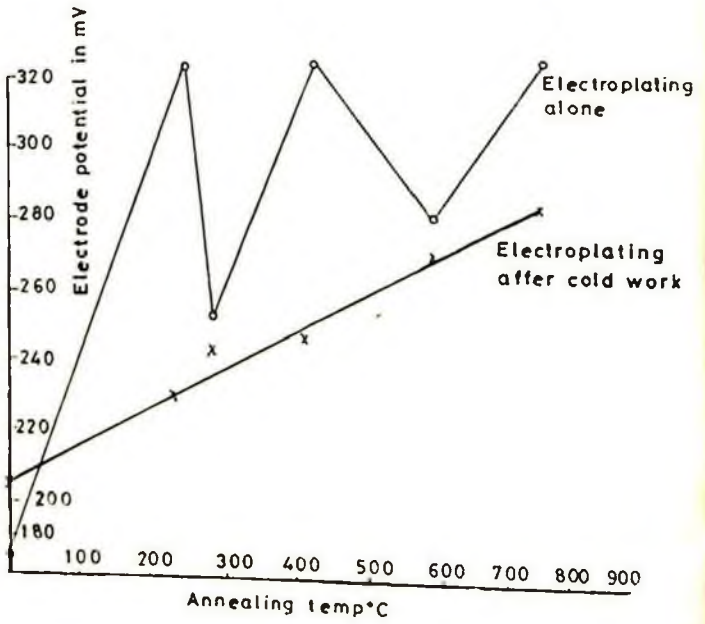


Fig. 1 The variation of electrode potential of annealed samples before and after electroplating.

B samples are divided into two groups : Samples annealed at 290 and 425°C show a peak in the e.p. versus cold-work-cycles curve. This is seen in fig.2(a). The rest of the samples show a monotonic behaviour (fig.2b). Curves shown in dotted lines represent the behaviour of samples before electroplating.

The electrode potential of a metal dipped in a solution of its own salt is (4)

$$E = E_o + \frac{RT}{F} \ln a \qquad \ldots(1)$$

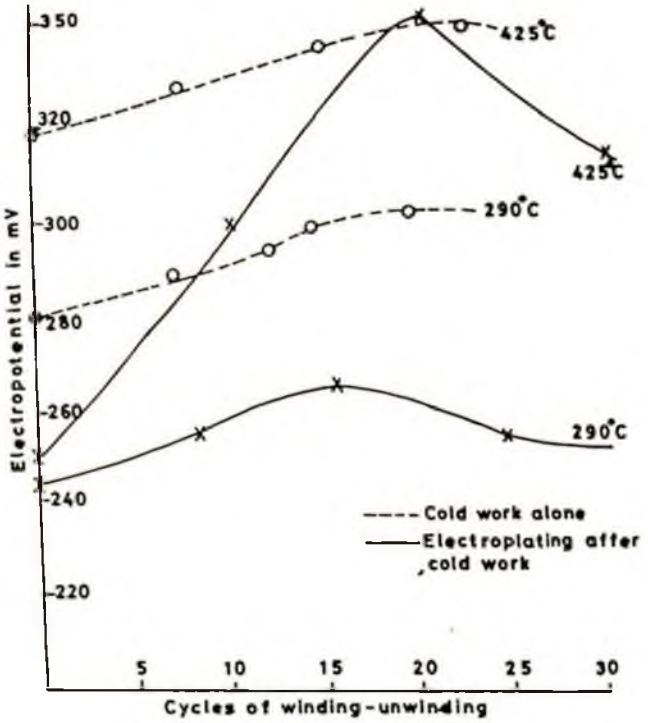


Fig. 2(a) Cycles of winding-unwinding

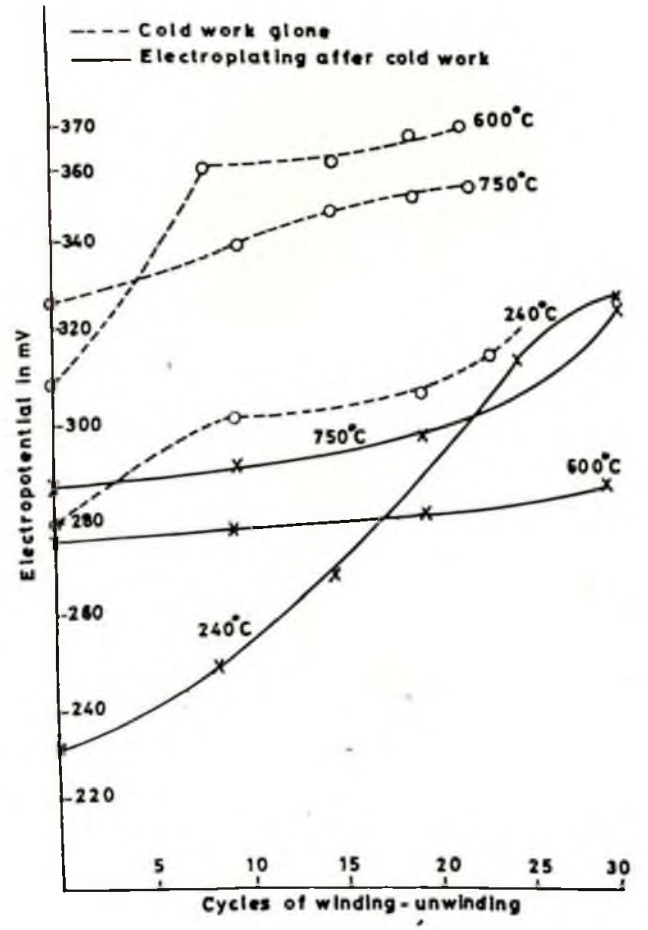


Fig. 2(b) Cycles of winding - unwinding

E_o is a quantity which is determined experimentally and varies from one crystal face to other (5). We, therefore, measured E_o in single crystals of nickel cut along (100), (110) and (111) faces finding the c.p. values respectively as 298, 392 and 336 mV against a calomel electrode.

If cold worked samples are left to themselves they attain a constant e.p. value -- the recovered value. These are representable in terms of the above mentioned single crystal face values as shown in Table 1.

TABLE 1

E.P. OF COLD WORKED SAMPLES IN TERMS OF SINGLE CRYSTAL E.P.

Annealing temp. °C	e.p. of cold worked samples (mV)	e.p. in terms of single crystal values	Peak value of e.p. after electroplating (mV)
240	312	2<100> + 1<111>	
290	296	<100>	260
425	334	<111>	350
600	346	4<111> + 1<110>	
750	342	8<111> + 1<110>	

Thus electroplated layer in 290°C annealed sample does not have <100> as a preferential plane but some other plane or a mixture of other planes giving a lower e.p. In 250°C annealed sample the <111> plane was intially the preferred plane at the surface but the electroplated layer has now a contribution also from <110> which has a higher e.p. However the new e.p. of the electrodeposit 350 = <111> + 1/28<110> i.e. a small fraction of <110> planes have become parallel to the surface.

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