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GROWTH MECHANISM OF HELICOIDAL NICKEL WHISKERS(*)

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I. INTRODUCTION

Nickel whiskers obtained by reduction of the iodide of the metal can be classified into two categories:-

- rectilinear whiskers
- spiral whiskers

Rectilinear whiskers without branches are obtained because one of the directions of dendritic growth is favoured and the development takes place only in that direction.

This paper presents a study of the growth mechanisms of helicoidal whiskers.

II. PREPARATION OF WHISKERS

The whiskers are obtained by hot reduction of nickel iodide. Decomposition of iodide takes place according to the following two reactions:

- By hydrogen:

$$I_2\,Ni + H_2 = Ni + 2I\,H$$

- By heat only

$$I_2\,Ni = Ni + I_2 \text{ (equilibrium of dissociation)}$$

The experiment is carried out between 900 and 980°C depending on the requirements.

III. GROWTH MECHANISM

1) General

It is known that a spiral dislocation can be formed from a mixed dislocation mainly of screw type,

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anchored at two points (these two points could be, for example, nodes of the network of Frank). The edge portions of the dislocation rise and drag the screw portions, which causes a curvature of the line and the formation of the helix.

This mechanism based on the climb of dislocations and the diffusion of punctual defects therefore involves a phenomenon activated thermally.

2) Application to Nickel Whiskers

Papapetrou's theory which is perfectly applicable to rectilinear whiskers does not explain the regular and systematic change of direction of growth of helicoidal whiskers. The climb of the spiral dislocations formed will explain these changes in the direction of growth if we assume the presence of a network of dislocations in the substratum formed by the nascent nickel lining the boats.

In fact, the growth of whiskers is effected by provision of metal at their tops. The helicoidal morphology would be a direct consequence of the rotation of the point of emergence of the dislocation along the helix. The process of growth, which is a consequence of the prismatic slip of the screw dislocation, will also describe this helix, and due to the crystalline system of nickel, this will lead to the formation of dense planes 111 limiting the lateral faces of the whisker. For a given concentration of vacancies there is a minimal radius of curvature of the dislocation line; this is one of the factors which determine the shape of the helix. Webb has discussed in the case of palladium the various factors influencing the shape of helices.

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