"The Work-Hardening Behaviour of Polycrystalline Copper during Interrupted Tensile Testing"

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by

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Read not to contradict and confute,

nor to believe and take for granted,

nor to find talk and discourse,

but to weigh and consider.

- Bacon: Essays.

ABSTRACT

The work described in this thesis represents the results of an investigation undertaken with the dual intention of

(a) establishing the apparatus and techniques necessary for carrying out investigations into the work-hardening behaviour of metals undergoing plastic deformation, and

(b) examining the work-hardening behaviour of polycrystalline copper during interrupted tensile testing.

The first part of the investigation required the development of the basic apparatus for investigations of the type envisaged. This apparatus included a tensile testing-machine, apparatus for the production of metal single crystals, apparatus for the determination of the orientation of metal single crystals and apparatus for the strain-free machining of metal single crystals. Details of the design and construction of this apparatus are presented.

The second part of the investigation required the assessing of the existing knowledge of work-hardening and the establishment of a programme aimed at contributing further to this knowledge.

A review is presented of information which pertains to the results of interrupted tensile tests such as those where the temperature dependence of the flow stress is examined, or the yield phenomenon produced by unloading is examined.

Some omissions and anomalies in this information are noted and

a programme of interrupted tests of the types described in the review is outlined for polycrystalline copper.

As a result of this programme, the following conclusions are made concerning the work-hardening behaviour of polycrystalline copper during interrupted tensile testing:

(a) polycrystalline copper obeys the Cottrell-Stokes law irrespective of the grain size or purity.

(b) copper single crystals of polyslip orientations obey the Cottrell-Stokes law.

(c) polycrystalline copper exhibits a yield phenomenon produced by unloading at all temperatures and strains. The magnitude of the change in flow stress associated with the yield phenomenon increases with decreasing temperature and is not significantly dependent on grain-size or purity. The magnitude of the change in flow stress increases with increasing strain and passes through a maximum.

(d) the magnitude of the change in flow stress associated with the yield phenomenon produced by unloading in polycrystalline copper increases as the amount of unloading increases.

TABLE OF CONTENTS

LIST OF FIGURES

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