# LETTERS TO THE EDITORS

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Striated Structure of Age-hardened Alloys

IT is well known that age-hardening of alloys is related to a transformation of the crystal lattice, which takes place inside the crystal : this transformation precedes and prepares the formation of the precipitate from the over-saturated solid solution.

The microscopical examination of the crystal surface in the earlier stages of age-hardening shows the existence of one or several systems of parallel striations (see refs. 1, 2 for aluminium-copper alloys (5 per cent Cu) ; refs. 3, 4 for copper-beryllium alloys (2 per cent Be) ; ref. 5 for aluminium-zinc alloys, etc.). These striations appear on the sample surface after polishing and convenient etching (see illustration) ; but they may also appear in another way. If the quenched sample is first polished, then age-hardened, the metal surface becomes spontaneously striated : in the case of copper-beryllium alloys, for example, the depth of the striations is very noticeable.
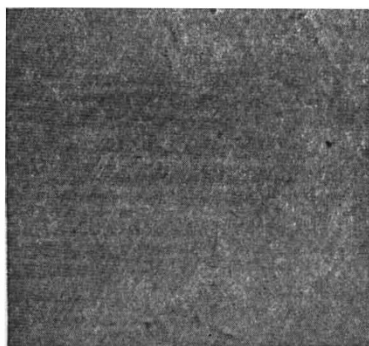
(a) Copper-beryllium, aged 4 hr. at 315°, after electrolytic polishing.
(b) Direction of crystallographic planes, determined by X-ray pattern.

(100) or (111) planes
(110) planes
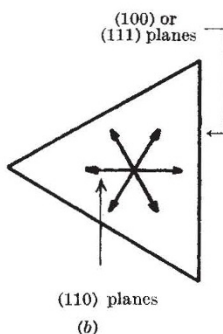
What is the origin of these striations which follow on age-hardening ? Opinions are widely divergent. According to some, they are the trace of glide planes on the sample surface, gliding being due to mechanical stresses produced by the lattice transformations accompanying the age-hardening. On the other hand, Wassermann[6] attributed the striated structure not to glide-planes, but to mechanical twinning resulting from quenching stresses. A third explanation which has been proposed is the following : the striations are due to the presence of a very fine-grained precipitate, the size of the crystallites being below the resolving power of the best microscopes. The formation of lines of determined orientation are due to the plate-shaped form of the initial grains of precipitate, which has been demonstrated by X-ray-scattering patterns. But this explanation is not consistent with the spontaneous appearance of striations on an alloy surface polished before age-hardening and not etched.

A way of deciding between these hypotheses seemed to us to be the determination of the orientation of the striation in relation to the crystal axes. Then, if the striations are due to gliding, they must be parallel to (111) planes (in the case of aluminium and copper alloys) ; but if they are due to some precipita-

tion, it might be expected that they would be parallel to (100) planes, since the crystals of the precipitate are flat and directed along those planes[1,3].

We have carried out this experiment with very coarse-grained samples, in the case of copper-beryllium and aluminium-copper alloys. The crystal axes were determined by back-reflexion Laue patterns. We found that all observed striation systems are *parallel to the intersection of some (110) planes with the examined surface*. But each (110) plane does not give rise to a striation system. Thus the striated structure of age-hardened alloys is neither related to ordinary glide-planes nor to precipitation planes.

The following explanation accounts for our observations. In the two alloys examined, the solid solution transformation begins by the gathering of the solved atoms in small areas of some (100) planes. Further, the local enrichment in foreign atoms of these planes produces variations of the interplanar (100) spacings. In the case of copper-beryllium alloy, for example, the parameter of the cell decreases from 3·6 A. (solid solution lattice) to 2·7 A. (precipitate lattice) : then the domain where the beryllium atoms are gathered undergoes a great diminution of volume, which produces the observed depressions upon the metal surface. We may assume that the dislocations between beryllium-rich domains and undisturbed crystal regions take place along (110) planes : for these planes are normal to base planes of the precipitate and are very important both in the solid solution and precipitate crystals. The result is that the striations, which are the limits between depressions of different value, are parallel to (110) planes.

In the case of aluminium-copper alloys, the difference between the volume of solid solution and precipitate is much less than for copper-beryllium alloys ; and it is observed, in fact, that the striations are much less pronounced.

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Structure of Adenosine Di- and Tri-Phosphate

DEFINITE proof of the constitution of adenosine diphosphate and adenosine triphosphate, desirable because of its significance both for the structure of the co-dehydrogenases and of the intrinsic interest of the adenosine polyphosphates, has not hitherto been presented. The usual formulation of adenosine triphosphate as adenosine 5'-triphosphate (I) (Lohmann[1]) is in doubt only as regards the mode of attachment of the labile phosphoryl groups to the 5'-phosphoribofuranoside residue ; the formation of muscle adenylic acid (adenosine 5'-phosphate) on hydrolysis of adenosine triphosphate and of inosine triphosphate by deamination virtually excludes the location of these phosphoryl groups elsewhere in the molecule.