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Question Sheet 1 on Alloys

1. The interaction between dislocations has consequences on deformation and transformation theory.

   (a) In a cubic close–packed metal, a dislocation with Burgers vector $\mathbf{b} = \frac{a}{2}[1\ 0\ \bar{1}]$, lying on slip plane $(1\ 1\ 1)$, is cut by a dislocation with $\mathbf{b} = \frac{a}{2}[1\ 0\ 1]$ gliding on $(\bar{1}\ 1\ 1)$. Describe the jog produced on the first dislocation.

   (b) Explain why interfaces between martensite and austenite can only contain one set of glissile dislocations. Why must these interfacial dislocations lie along an invariant–line in the interface?

2. The European Airbus A320 uses an alloy designated 2014 with a typical composition:

   Al–0.7Si–0.8Mn–0.5Mg–4.5Cu–1.0 other, wt%

It's yield strength is 275 and 410 MPa in the $T4$ and $T6$ conditions respectively. Explain which condition would be appropriate for this application and the way in which the parts could be joined. Comment also on any corrosion susceptibility of the alloy as a whole and how this might be improved.

3. Comment on the following features of titanium alloys and steels:

   (a) The eutectoid reaction in Fe–C can occur at temperatures as low as 400 °C whereas that in Ti–Cu alloys is very sluggish.

   (b) The martensite in alloys which are β–Ti at high temperatures is not particularly hard when compared with the parent phase. Steel martensite is much harder than the parent austenite from which it forms.

   (c) Both titanium and steel melt at temperatures in excess of 1500 °C. Steel can be used at temperatures as high as 1000 °C but titanium cannot. Why is this?

   (d) Both titanium and α–iron are embrittled by hydrogen but by different mechanisms.

4. Give two reasons why the use of titanium alloys is increasing at the expense of aluminium in both civil and military aircraft.

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