Answer Sheet 1 on Alloys

1. The jog will be along [1 0 1], which is not on (1 1 1) rendering the dislocation sessile.

   If the interface has more than one set of dislocations these may interfere in the manner of jogs. This would cause the interface to become sessile. Note that if glissile jogs arise then it is not necessary to have more than one set of dislocations to accommodate the misfit.

   The dislocations must lie along the invariant–line because there is no distortion along that line. If there is any distortion along the dislocation line then it would have to be accommodated by another set of misfit dislocations.

2. $T4$ is solution treated and naturally aged, $T6$ is solution treated and aged. It would be used in the aged condition. Joining would be with rivets because soft heat–affected zones associated with welding are unacceptable. Al–Cu alloys are susceptible to stress–corrosion due to precipitate–free zones. These can be minimised using two–state heat–treatment: nucleate precipitates at a low temperature where homogeneous nucleation possible, grow, and then heat to higher temperature for further rapid growth. Note that growth at the lower temperature is essential to avoid reversion of the nuclei when the temperature is raised. Alternatively, the alloy can be clad with a thin layer of pure aluminium.

3. The eutectoid reaction in titanium alloys involves the long–range diffusion of substitutional solutes. The martensite in titanium alloys has substitutional solute hardening. The substitution of an atom in the lattice causes isotropic strains which mainly interact with the hydrostatic components of dislocation strain fields. In body–centred cubic iron, the interstitial carbon causes tetragonal strains which also interact with the shear components of the dislocation strain fields. This gives potent hardening. Note that this also explains why carbon has a much smaller strengthening effect on the strength of austenite, where the octahedral holes in which the carbon resides are isotropic.

4. Titanium tends to burn at high temperatures. (This has not been explained in lectures but I have asked the students to read various sections of *Light Alloys* by Polmear).

   Titanium embrittles by hydride formation which is associated with a large (18%) volume expansion. In steel the dissolved hydrogen reduces cohesion across grain boundaries, and in general reduces the cohesive strength of iron. (The steel part is not covered in C9, but in the Part IB Course A lectures).

   In civil–aircraft, design changes require higher strength than aluminium alloys are capable of providing. In military aircraft, high speeds lead to high skin temperatures which again cannot be tolerated by age–hardened aluminium alloys.

Part IIa,b Course C9, H. K. D. H. Bhadeshia