Answer Sheet 2 on Alloys

1. Widmanstätten ferrite plates observed optically consist of a pair of self–accommodating plates which grow cooperatively so that their shape deformations approximately cancel. Hence can form at low undercoolings.

2. Assume that the plates grow right across austenite grains and that all the driving force is used up in strain energy.

$$E = \frac{c}{r}\mu(s^2 + \delta^2)$$

where E is the strain energy per unit volume, μ is the shear modulus of the austenite, c is the thickness of the martensite plate, r is the length of the martensite plate and, s and δ are the shear and dilatational strains of the shape deformation of martensite. r is set to the austenite grain size since the plates are limited only by the austenite grain boundaries, giving 2.46×10^{-6} and 8.18×10^{-6} m as the answers.

3. Combination of two invariant–plane strains is equivalent to an invariant–line strain, with the invariant–line at the intersection of the two invariant–planes, i.e. $[\overline{1}\ 1\ 0]$.

4. The table below assumes a metal with a cubic lattice.

	Annealing	**Mechanical**	**Martensite**
Shape change	none	shear	invariant–plane strain
Shear strain	–	$\frac{1}{\sqrt{2}}$	$\simeq 0.25$
Dilatational strain	–	–	$\simeq 0.03$ in steel
Density change	–	–	yes
Crystal structure change	–	–	yes
Morphology	blocky	lenticular	lenticular