Ferromagnetic materials: Domain Walls

Domain walls are the regions between domains where the direction of magnetisation must change, usually by either 180° or 90°.

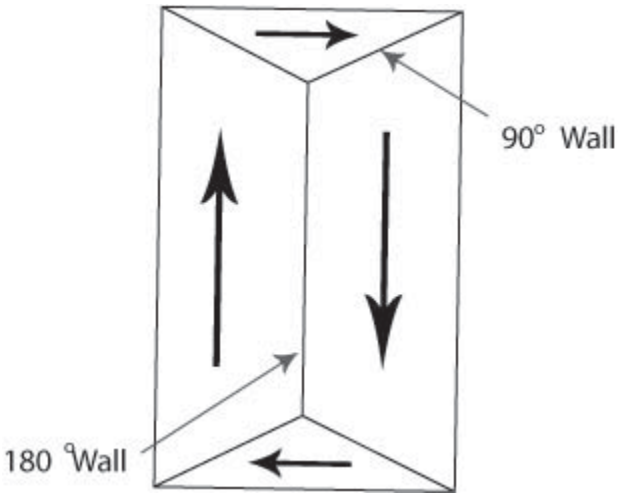

Figure O. Diagram showing domain walls.

The width of domain walls is controlled by the balance of two energy contributions:

- Exchange energy
- Magnetocrystalline energy

The exchange energy favours wide walls where adjacent magnetic dipole moments can be as close to parallel as possible, whereas the magnetocrystalline energy favour sharp changes in the dipole moments between the favoured directions in the crystal so that as few dipole moments as possible point along “non-easy” directions. The actual width is determined by the minimum of the total energy.

The most favourable domain walls are those which do not require an external demagnetising field. Three walls, or “boundaries” of this type are discussed below.

1. Twist Boundary

   The magnetisation perpendicular to the boundary does not vary across the domain wall hence no demagnetising fields are generated.

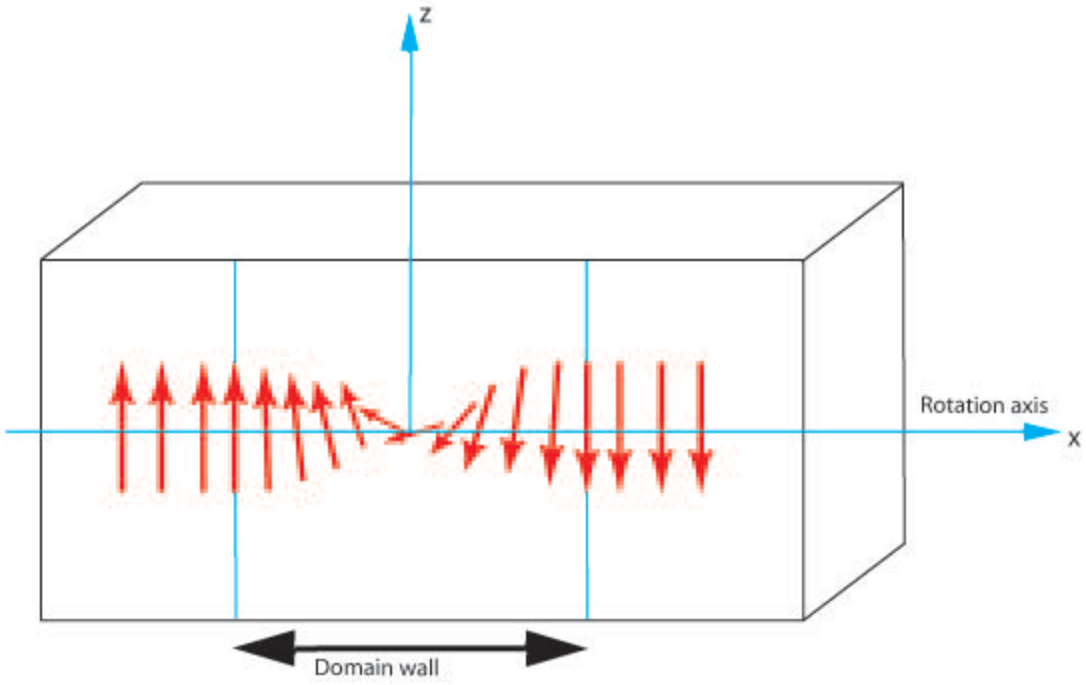

Figure P. Diagram showing the rotation of magnetic moments through a 180° domain wall.

2. Tilt Boundary

   The magnetic moments rotate in such a manner that a constant angle is maintained between them and both the wall normal and the surface.

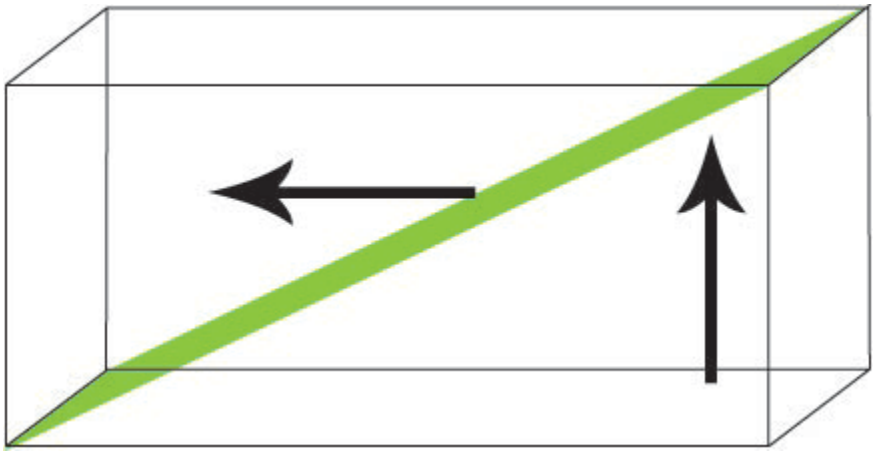

Figure Q. Diagram showing the rotation of magnetic moments in a tilt boundary

3. Néel Wall

   In thin films a Néel wall occurs, and the magnetic dipole moments rotate around an axis perpendicular to the surface of the film. These are favourable in thin films because the free poles are formed on the domain wall surface rather than the film surface, causing a reduction in magnetostatic energy.

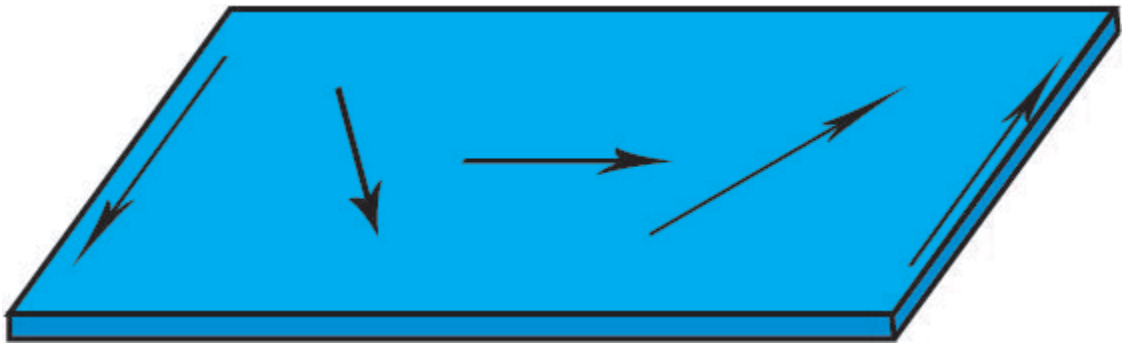

Figure R. Diagram showing the rotation of magnetic moments in a thin film in a plan view.

Source : http://www.doitpoms.ac.uk/tlplib/ferromagnetic/walls.php