which is definitely smaller than in the fully annealed state. There is then a rapid increase in magnetization known as the Barkhausen effect, and finally the approach to saturation occurs at higher fields than in the fully annealed state. In the large field range, the reduction in magnetization produced by work-hardening can be represented by:

$$\Delta M = \frac{q}{H} + \frac{p}{H^2},$$

where p and q are constants. This relationship holds in the stage of rapid hardening. We believe that during the initial stages of work-hardening the term q/H is associated with the work-hardening of dislocation dipoles. Once work-hardening dominates, however, the first term is connected with the relaxation of piled-up groups.

It is generally known that at low fields and in well-annealed polycrystals with large grains, Bloch walls are made mobile under the applied field. In worked material, under very small fields, the walls are able to bend between their pinning points, giving rise to the initial permeability. Above a critical field H_c the walls escape from their pinning point and move irreversibly, giving rise to the Barkhausen jump. The large number of piled-up groups of dislocations introduced by shock loading provides at least some of the pinning points. The pinning energy per unit length of dislocation is of the order of $\lambda\sigma\delta^2 \simeq \lambda\mu b\delta$, where λ is the magnetostriction, δ is the width of the Bloch wall, μ is the shear modulus and b is the interatomic distance. The average stress σ is computed in a cylinder of diameter δ around the dislocation. H_c is obtained by equating this energy to $H_c M_s S\delta$ which is the energy gained from H_c when a length $2S$ of Bloch wall moves forward by δ. Therefore

$$H_c \simeq \frac{\lambda\mu b}{S} M_s.$$

The above equation explains the order of magnitude of the initial permeability of the Barkhausen effect (Dektyar and Levina 1962).

Hence, we have identified three regions of magnetization, each of which has been related to the metal's dislocation and domain sub-structure. The increase in susceptibility is due to a shock-induced magnetic transition.

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