CHAPTER III

APPLICATION TO THE SHOCK INDUCED ANISOTROPY EFFECT

Passage of a shock wave through an infinite half space of ferromagnetic material creates, behind the shock, an infinite slab of ferromagnetic material in a state of uniaxial magnetic anisotropy normal to the plane of the slab. An external magnetic field is applied along a direction in the plane of the slab and, hence, orthogonal to the axis of uniaxial strain as seen in Figure 3.1. This chapter will utilize the thermodynamic tools developed in the preceding chapter to predict the magnetic behavior of a ferromagnet subject to this unique effect.

To proceed from the given energy expression to the final prediction of a magnetization curve in a given magnetic problem requires considerable effort and has been the subject of much theoretical investigation for many years. There have been basically two theoretical approaches to the problem. The more

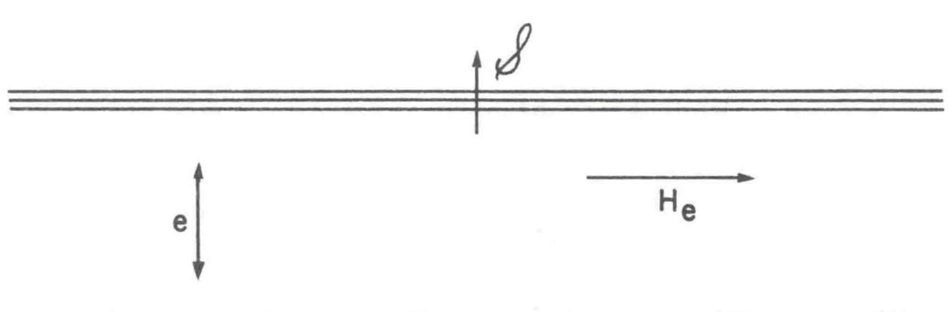

Fig. 3.1.--Shock created anisotropic ferromagnet.

contemporary theory is referred to as micromagnetism.[31] It assaults the energy minimization problem through calculus of variation techniques. This theory is more general; capable, in principle, of predicting domain walls, hysteresis, Barkhausen jumps, and other characteristic ferromagnetic properties. Its usefulness, however, is limited by the extreme complexity of the mathematics involved and little progress has been made except in the simplest geometries.

The other approach is domain theory.[4,32] It has enjoyed wider acceptance due to its ability to provide useful predictions in practical magnetic problems. Domain theory avoids the difficult mathematics brought about by the calculus of variation methods. This is accomplished by postulating the presence of domain walls in the material and considering the exchange energy as localized in these walls. Success of this theory rests on the ingenuity and experience of the theoretician since he must determine by extratheoretical consideration the domain goemetry which will create the lowest energy.

This chapter will proceed by considering the shock induced anisotropy effect in single crystal material. The problem will be analyzed with established tools of domain theory and by these methods will be carried to its logical conclusion. The next step toward predicting the magnetic behavior in real material is the consideration of a theoretically dense polycrystal with random texture. This problem is explored and the averaging procedures relating single crystal behavior to polycrystal behavior are defined. Following this will be a brief review of the success of micromagnetic theory in exploring the anisotropy effect. In the last section the perturbing problem of porosity, present in all natural material, is considered.