CHAPTER VI

DISCUSSION AND CONCLUSIONS

6.1. Discussion

The use of equilibrium thermodynamics to describe the behavior of the shocked ferromagnetic material assumes that equilibrium is reached within a few nanoseconds after passage of the shock wave. Magnetic relaxation times observed by other methods suggest that this very likely occurs. However, the results of the present work lend additional confidence to this assumption.

Within the concepts of domain theory, an analysis of the shock induced anisotropy effect on magnetic single crystals has established the following. The equilibrium exchange and dipolar energy increases as the fourth root of the strain while the magnetoelastic anisotropy energy increases linearly with the strain. This means that the contribution of the exchange and dipolar energy to the magnetic behavior is significant at low strains but becomes negligible in the high elastic and plastic region. It was deduced that domain walls in the direction of strain with normals either perpendicular or parallel to the applied field differed only slightly in wall energy. This small energy difference is probably nullified by local crystal defects. However, domain walls normal to the axis of strain incur high energy due to the magnetic volume poles created. It is logical to conclude that a needle or sliver shaped domain structure oriented in the direction of uniaxial strain nucleates behind the shock wave. The magnetization curves predicted for the <100> and <111> problems are linear and differ substantially. This is a consequence of the magnetoelastic anisotropy of YIG $(b_1 \neq b_2)$.

In considering the shock induced anisotropy effect on magnetic polycrystals, a critical analysis of the necessary averaging procedure is required. This analysis is concerned with the magnetic interaction between crystal grains. A definition of extreme assumptions concerning the interaction was made in analogy with the procedure used to determine polycrystalline elastic constants.

From one extreme, the interacting grain theory follows. The physics necessary to make this behavior plausible requires an extra-grain domain structure. This in turn demands sufficient contribution from exchange and dipolar forces to make continuous domains across grain boundaries energetically favorable.

Independent grain theory is the other extreme. This behavior is expected if an intra-grain domain structure occurs. Such domain structure arises when exchange and dipolar forces are insufficient to overcome anisotropy forces.

In the present work, experimental data concerning the shock induced anisotropy effect have been obtained for polycrystalline yttrium iron garnet in the region of large elastic strain. The results, presented in Figure 5.6 and Figure 5.7, support the shock induced anisotropy mechanism as a contribution to shock demagnetization. It is further concluded that the independent grain assumption provides a better description of the magnetic behavior of ferromagnetic material in the shocked state. Also established is the validity of the parameter H_e/e in characterizing the magnetization curve. This is seen in Figure 5.7 where the experimental magnetization curves, plotted as a function of this parameter, are self similar.

In retrospect, independent grain behavior appears more logical than interacting grain behavior. Domain theory predicts that the equilibrium