ABSTRACT

In this project funded by the Chemical Structure, Dynamic & Mechanism B Program of the Chemistry Division, Professor David H. Waldeck of the Department of Chemistry at the University of Pittsburgh will explore how electrons have their magnetic dipoles aligned with respect to the direction of their velocity by very thin films of material (either metal oxides or polypeptides). The goal of this research is to understand how the helical structure of molecules affects the direction of an electron's magnetic moment and to examine whether those characteristics can be incorporated in thin metal oxide films for creating electron currents that have a preferred direction for the spin magnetic moments. The alignment of electron magnetic moments and their manipulation in circuits could have important implications for the design and creation of new types of information memory devices. The project lies at the interface of materials chemistry and physical chemistry, and it is well suited to the education of scientists at all levels. Outreach activities to Pittsburgh area schools (middle school and high school) through a Science Kit Lending Library will also be part of the funded project. The collaboration with a German group and an Israeli group will provide a beneficial international experience for the student researchers.

Recent experiments (and theory) show that as electrons move through a chiral molecule (or structure) they generate an effective magnetic field which acts to align the electrons' magnetic moment to the propagation direction. The proposed experimental studies aim to elucidate how structural features of chiral thin films affect the degree of spin alignment. In one thrust of the work, monolayer thick films of helical molecules will be examined to see how the spin alignment is affected by the helix structure (pitch, length, etc.). In a second thrust of the work, the focus is on how the spin alignment for electrons transmitted by ultrathin chiral films of metal oxides depends on the metal oxides energy band location and the film's thickness. These latter studies could have important implications for the design of new electronic devices, such as spin-torque memories. These studies are designed to identify the important features that will need to be incorporated to achieve a quantitatively accurate theoretical model of the chiral induced spin selectivity effect.