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Physics III

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Albert Fert

In 2007 Albert Fert won the Physics Nobel Prize. Fert was born on March 7, 1938 in Carcassonne, France. Fert attended the Ecole Normale Supérieure, which is where he explored his interest in physics. His time at the university eventually swayed him towards learning sciences. Jacques Friedel, the creator of the master's program at the university, persuaded Fert to study in Quantum mechanics and statistical mechanics. Eventually this interest in the field, led him investigate condensed matter physics. Fert began his doctorate through the testing of the theory that the mobility of electrons in a ferromagnetic metal depends on the orientation of their spin in relation to their magnetic orientation, which was the work of Neville Mott. Throughout his investigation especially during the 1970s, Fert realized that improved technology was necessary for him to continue his research and to progress in physics. In July 1988 Fert and other partners had the chance to present their work on giant magneto resistance in Fe/Cr multilayers. The presentation was ultimately a failure as it sparked little reaction from the scientific community. Throughout the 1980s Fert and his accomplices would refine and build upon their research and then finally they hit a "fruitful time of research" (Fert) in the 1990s.

The project and research that allowed Fert to win the Nobel Prize in Physics was his involvement in the Giant Magneto Resistive Head, which was a giant leap for the IBM research. Fert realized that there are large resistance changes in materials from anywhere between 6

percent to 50 percent in materials that are consisted of and comprised of multiple metallic elements. The experiment was conducted in a control atmosphere where there was a presence of high magnetic fields, and with low temperatures, and there was the utilization of numerous materials that were grown, but unable to mass produce. The discovery led to widespread inquiry and experimentation by other scientists to test how they could harness the power of the Giant Magneto resistive effect or replicate the results. The change in resistance occurs when the multilayer arises when the applied field aligns the magnetic moments into the proceeding ferromagnetic layers are antiparallel. The application of the magnetic field aligns the magnetic moments and saturates the magnetization of the multilayer, which leads to a drop in the electrical resistance of the multilayer.

The phenomenon of GMR in magnetic metallic layered structures, led to these new structures which include magnetic multilayers, spin valves, pseudo spin valves, and granular solids. Magnetic multilayers are able to be used because of antiferromagnetic interlayer coupling. The coupling is mediated by electrons in the metallic spacer layer and continuously oscillates between ferromagnetic and antiferromagnetic as a function of the thickness of the nonmagnetic layer. By choosing an appropriate thickness it enables a person to create an antiparallel configuration and align the moments by an applied magnetic field. A pseudo spin valve can obtain alignment due to varying coercivities of the two ferromagnetic layers, this allows for a higher resistance to be created. A spin valve can be used because it magnetizes one of the ferromagnetic layers and spins the exchange coupling with an adjacent antiferromagnetic layer, while the other layer is free to rotate with the force from the magnetic field. Only small magnetic fields need to be applied to change the resistance. Granular solids are another system that can be

used, and Ferromagnetic precipitates are embedded in a non-magnetic host and this precipitation causes the amount of resistance to drop.

The finding of the GMR will transform the computing industry, as computers will no longer be relegated to the desktop but can now be more readily available in cars, TVs, laptops, etc... The new finding allows for mass storage of files also and leads to the increase of people moving away from simple means into digital means. This means that things such as newspapers, essays, and other documents will be able to transition into the digital realm and be stored for much accessible locations. A world where all documentation becomes available on the computer and is no longer available in paper form can become possible as a result of the GMR. The GMR also strongly affects the sensor industry as it increases or creates new methods for scientists to create better sensing by the computer. The main company benefitting from the research as of right now is IBM, a technology distributor.

In conclusion, the 2007 Nobel Prize winner, Albert Fert, strongly contributed to the finding of the giant magneto resistance, which is the change in electrical resistance of materials in response to an applied magnetic field. These materials include magnetic multilayers, spin valves, pseudo spin valves, and granular solids. This allows resistance to either be lowered or heightened depending on the material chosen, and this discovery marks a huge step in technology, because we as humans have met in achieving total digitalization of current paper document, as a result of Albert Fert's contribution.

Sources

http://physics.unl.edu/tsymbal/reference/giant_magnetoiresistance/gmr_structures.shtml

http://www.nobelprize.org/nobel_prizes/physics/laureates/2007/fert-or.html

<http://www.research.ibm.com/research/gmr.html>