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Albert Fert

The 2007 Physics Noble Prize winners were Albert Fert and Peter Grunberg. Fert was born on March 7, 1938 in Carcassonne, France and Peter Grunberg was born on May 18, 1939 in Czechoslovakia. Fert attended the Ecole Normale Supérieure between the ages of 19 and 24 where he would continue to explore his interest in physics. The school was in the heart of Paris so Fert become extremely fond of the culture of the city and would become an avid fan of jazz music. Fert eventually even wrote a script and made a film about jazz. He states that eventually swayed towards the sciences as a result of outstanding physics professors at the university. Quantum mechanics and statistical mechanics were the original interests of Fert after being exposed by the creator of the master's program at the university, a man by the name of Jacques Friedel. Eventually this initial interest in physics led to his investigations within condensed matter physics. After returning from the military in 1965, Fert began his doctorate through the testing of another future Nobel Prize laureate, Neville Mott. Albert Fert sought to test Neville's theory that the mobility of electrons in a ferromagnetic metal depends on the

orientation of their spin in relation to their magnetic orientation. Throughout his studies, especially in the 70s, Fert began to realize that improved technology was necessary for him to continue his research and 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 due to the limited time Fert's student, Frédéric Nguyen Van Dau, had to present the material. The presentation sparked little reaction from the scientific community. Throughout the 80s Fert and his accomplices would refine their research and then hit a "fruitful time of research" (Fert) in the 90s.

The research that won Fert the Nobel Prize in physics was his involvement in the Giant Magneto resistive Head which is a giant leap for IBM research. Fert recognized that large resistance changes anywhere from 6 percent to 50 percent in materials comprised of multiple metallic elements. This experiment was performed at low temperatures and in the presence of high magnetic fields and utilized numerous materials that were grown and unable to be mass produced. The discovery led to widespread experimentation by other scientists to test how they could harness the power of the Giant Magneto resistive effect. 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, these structures include magnetic multilayers, spin valves, pseudo spin valves, and granular solids. Magnetic multilayers can 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 eventually leads to a higher resistance to be created. A spin valve can be used because it magnetizes one of the ferromagnetic layers and pins 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. Ferromagnetic precipitates are embedded in a non-magnetic host. This precipitation causes the amount of resistance to drop.

The finding of the GMR will transform the computing industry. Computers will no longer be relegated to the desktop but 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 mean into digital mean. This means that things such as newspapers, essays, and other documents will be able to transition into the digital realm and be stored for easy access. Imagine a world where all documentation becomes available on the computer and is no longer available in paper form, the GMR makes this possible. The GMR also strongly affects the sensor industry. It increases 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 some 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. This discovery marks a crucial objective met in achieving total digitalization of current paper documents.

Sources

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

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

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