



Magnetic Semiconductors: p-n Junctions and Magnetic Bipolar Heterojunction Transistors

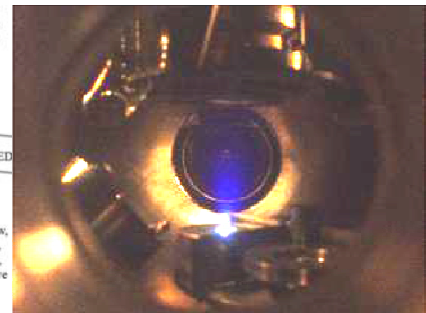
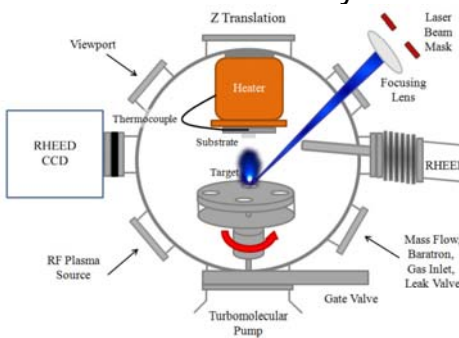
Research supervisor: Dr. Plamen Stamenov
Magnetism & Spin Electronics

Scientific Background / Current Research

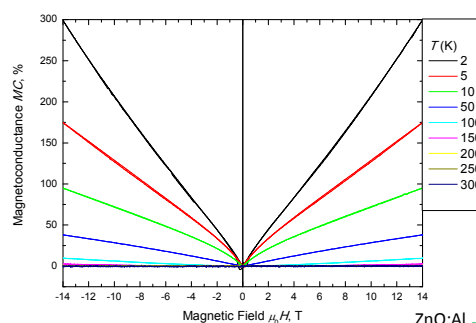
Magnetic Semiconductors are a class of materials that utilize the versatility and functionality of semiconductors, and take advantage of the spin degree of freedom, in order to enable key applications in modern *spin electronics* (not to be confused with the rather controversial class of *Dilute Magnetic Semiconductors*). The realisation of active electronic components with net spin gain is a 'holy grail' of spin electronics research, as it would enable the creation of spin-based logic gates and further development of components such as non-volatile programmable logic and storage arrays, among others. Magnetic-semiconductor-based devices are one of the ways forward.

Project

The project will involve the synthesis and characterisation of bulk ferro-, ferri- and antiferromagnetic semiconducting systems (such as $\text{CuCrO}_2:\text{Mg}$ and CdCr_2Se_4) and the subsequent deposition of multi-layers stacks by Pulsed Laser Deposition (see diagram on the right), in collaboration with the group of Prof. J. Lunney, and the formation of *diode* and *transistor* structures. The devices will be characterised using a variety of experimental techniques, including the use of high magnetic field transport, and synchrotron and neutron radiation.

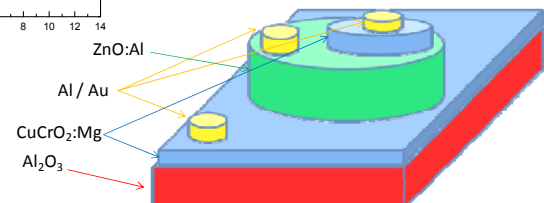


Schematic of the PLD tool used for thin film deposition (left) and an actual plasma plume within the system (right).. Image courtesy of J. Alaria and M. K. O'Sullivan



The magneto-conductance of a thin film of $\text{CuCrO}_2:\text{Mg}$ in high field (up to 14 T) at various temperatures, both below and above the antiferromagnet-paramagnet transition ($T_N \sim 25$ K). Note the very high magnitude of the effect (> 300 %) at low temperatures.

Schematic structure of the magnetic bipolar heterojunction transistors prepared by PLD with the use of in-situ shadow masking.



Funding

Funding for this project has been approved and is available through the School of Physics and CRANN, TCD.

Contact details

stamenov.plamen@tcd.ie Room no.: SNIAM 0.08 tel. +353 1 896 2171

More information / References

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- J. Fabian, I. Zutíć, and S. Das Sarma, *Phys. Rev. B.* **66**, 165301 (2002).
- <http://www.tcd.ie/Physics/People/Plamen.Stamenov>