

Recent developments and emerging directions in spintronics

Albert Fert

Nobel Prize Winner in Physics 2007,
Scientific Director, Unité Mixte de Physique CNRS/Thales, Palaiseau
Professor of Physics, Université Paris-Sud, France



[Abstract]

Spintronics develops today in many promising directions. We focus on three topics. First: “Microwave generation by spin transfer”, a field of research with fast recent advances anticipating applications at short term. Second topic: “Spintronics with graphene or carbon nanotubes (CNT)”, with fascinating long term prospects for “beyond CMOS”. Finally: “Oxitronics”, overview of results on devices associating magnetic, ferroelectric and multiferroic oxides.

1) Microwave generation by spin transfer

Microwave oscillations are obtained by using spin transfer to induce magnetization precessions or gyrations of magnetic vortices. Large powers (μW range) and narrow emission widths (≈ 0.1 MHz) can be today obtained at zero field by vortex gyration. Synchronization is an additional way to increase the power and reduce the emission width [2].

2) Spintronics with graphene and CNT

Several concepts of spintronics (logic gates, “spin only logic circuits”, etc) are based on spin transport in lateral channels between magnetic contacts. Recent experiments show the outstanding potential of graphene and CNT for spin transport to long distance (above $100\ \mu\text{m}$) in such devices.

3) Oxitronics

We illustrate the potential of oxitronics by results on tunnel junctions with ferroelectric barriers: giant electro-resistance [3], interplay between ferroelectric and spin polarizations, prospects for ferroelectric memories and memristors.

References

- [1] A. Dussaux, B. Georges, J. Grollier, V. Cros, A.V. Khvalkovski, A. Fukushima, M. Konoto, H. Kubota, K. Yakushiji, S. Yuasa, K. A. Zvezdi, K. Ando, and A. Fert, *Nature Communications* **1**, 8 (2010).
- [2] A. Dussaux, A. V. Khvalkovskiy, J. Grollier, V. Cros, A. Fukushima, M. Konoto, H. Kubota, K. Yakushiji, S. Yuasa, K. Ando, and A. Fert, *Appl. Phys. Lett.* **98**, 132506 (2011).
- [3] V. Garcia, S. Fusil, K. Bouzehouane, S. Enouz-Vedrenne, N.D. Mathur, A. Barthélémy, and M. Bibes, *Nature* **600**, 81 (2009).

