The study of Ferromagnetic/Antiferromagnetic Interfaces

with Magnetization-Induced Second Harmonic Generation*

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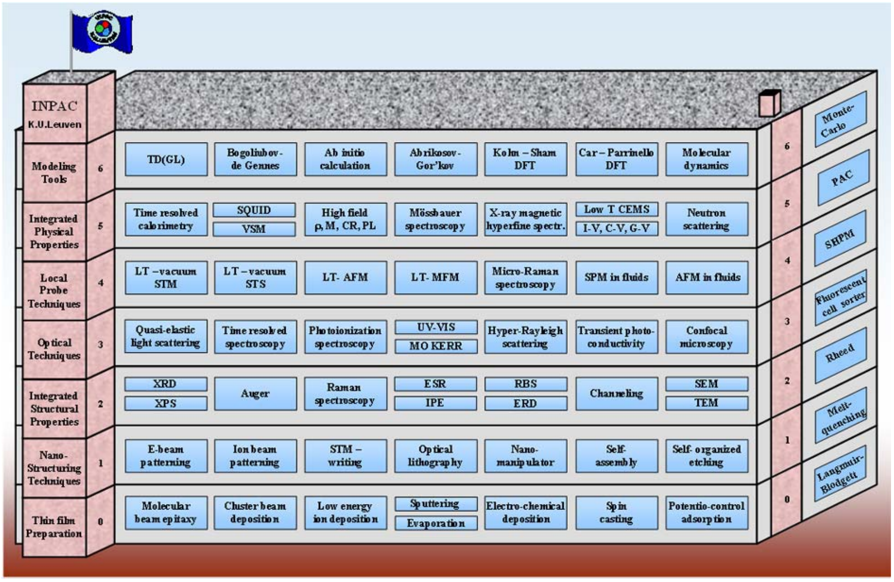
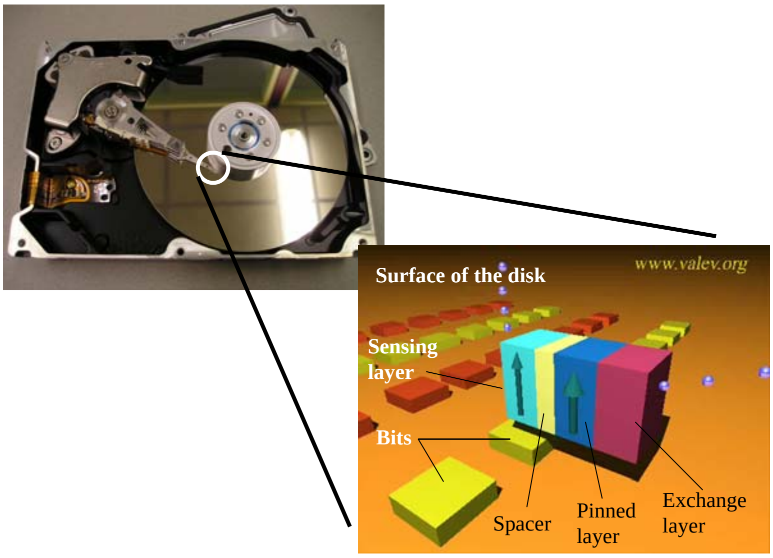
Molecular and Nanomaterials

* Based on Phys. Rev. B **75**,12401 (2007)

A new experimental technique for INPAC



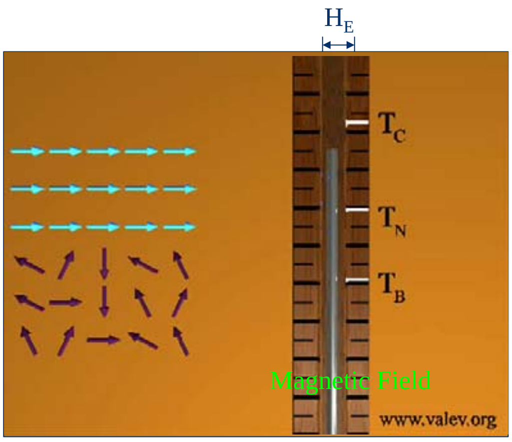
Spin-valves are widespread



Exchange bias

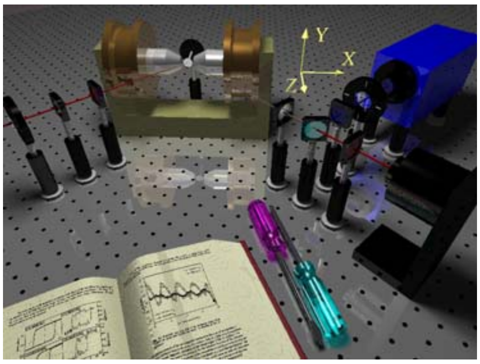
- Meiklejohn and Bean 1956
- FM/AFM interface
- Field-cooling

Curie temperature T_C
Néél temperature T_N
Blocking temperature T_B



Meiklejohn, Bean, Phys. Rev., **105**, 904

Complementary techniques



- **MSHG**
  - **interface-sensitive in the dipole approximation.**
- **Linear Magneto-Optical Kerr Effect (MOKE)**
  - **“bulk”-sensitive**

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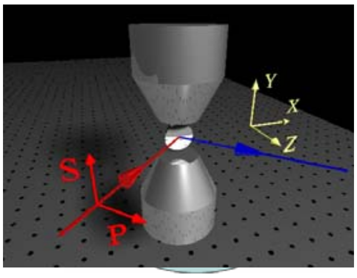
MSHG



For intense electromagnetic fields:

$$\mathbf{P} = \chi^{(1)} \cdot \mathbf{E} + \chi^{(2)} \cdot \mathbf{EE} + \chi^{(3)} \cdot \mathbf{EEE} + \dots$$

Magnetic field induces an additional term:

$$\mathbf{P}_i(2\omega) = \chi_{ijk}^{nm} \cdot \mathbf{E}_j(\omega)\mathbf{E}_k(\omega) + \chi_{ijkl}^{m} \cdot \mathbf{E}_j(\omega)\mathbf{E}_k(\omega)\mathbf{M}_l$$

And the MSHG intensity is: $I(2\omega) \propto \left|\chi^{nm} \pm \chi^{m}\right|^2 I^2(\omega)$

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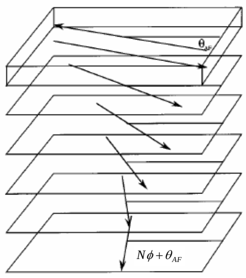
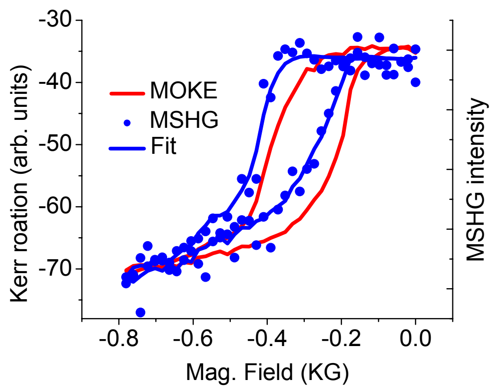
A ferromagnetic domain wall?

Different loop shift H_E & coercivity H_C!



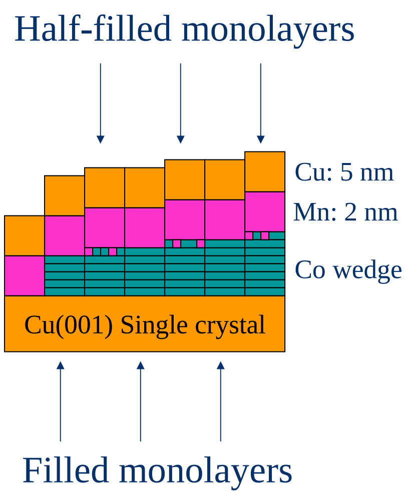


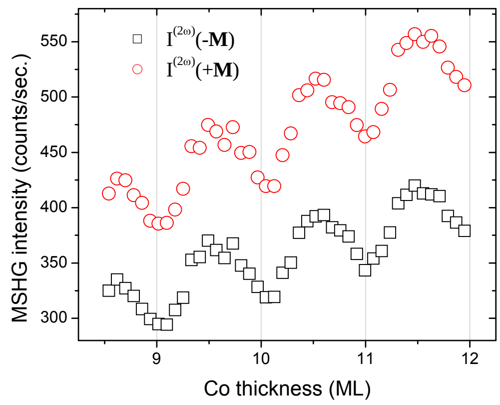
$$I(2\omega) \propto \left|\chi^{nm} \pm \chi^{m}\right|^2 I^2(\omega)$$

$$I(2\omega) \propto \left(\left|\chi^{nm}\right|^2 + \left|\chi^{m}\right|^2 \pm 2\left|\chi^{nm}\right|\left|\chi^{m}\right|\right)\cdot I^2(\omega)$$

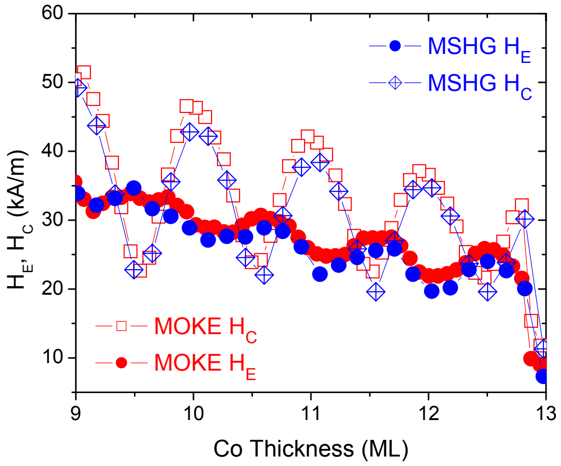
$$\left|\chi^{m}\right|/2\left|\chi^{nm}\right| \ll 1$$

Well controlled interface





Bulk vs. interface magnetization



There is no domain wall forming in the ferromagnet!

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Conclusions

- MSHG allows the successful investigation of FM/AFM interfaces.
- It is a suitable technique for INPAC
- MSHG can be applied to systems combining magnetism and a lack of centrosymmetry, such as surfaces, interfaces, chiral materials, etc.

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