School on *Nanomaterials for magnetism and spintronics*

Ecole Franco - Coréenne

IPCMS Université Louis Pasteur - Strasbourg

LPM Université Henri Poincaré - Nancy

Ewha University - Séoul

18-23 FÉVRIER 2008

PROGRAMM

MONDAY FEBRUARY 18, 2008

9h15-9h30 - Welcome B. Doudin (Strasbourg)
9h30-10h15 - Introduction W. Weber (Strasbourg)
10h15-11h00 - Thin films and nanostructures, fabrication and properties (1) P. Panissod (Strasbourg)
11h30-12h15 - Thin films and nanostructures, fabrication and properties (2) P. Panissod (Strasbourg)
12h-13h00 - Materials for Spintronics T.H. Kim (Seoul)

15h00-15h45 - Transport through magnetic domain walls D. Weinmann (Strasbourg)
15h45-16h30 - Nanoparticles (1) G. Pourroy (Strasbourg)
17h00-17h45 - Nanoparticles (2) G. Pourroy (Strasbourg)

TUESDAY FEBRUARY 19, 2008

9h30-10h15 - Magnetic oxides A. Maignan (Caen)
10h15-11h00 - Ferroelectric materials A. Maignan (Caen)
11h30-12h15 - Multiferroics A. Maignan (Caen)
12h15-13h00 - New switching molecular systems (1) J.F. Letard (Bordeaux)

15h00-15h45 - New switching molecular systems (2) J.F. Letard (Bordeaux)
15h45-16h30 - Carbon-based spintronics (1) J. Trbovic (Basel)
17h00-17h45 - Carbon-based spintronics (2) J. Trbovic (Basel)

WEDNESDAY FEBRUARY 20, 2008

9h30-11h00 - Spin electronics devices and design (1+2) M. Hehn (Nancy)
11h30-12h15 - Current-induced switching : spin transfert torque S. Mangin (Nancy)
12h15-13h00 - Magnetoelectric interfaces and ferroelectric tunnel junctions (1) E. Tsymbal (U. of Nebraska)

15h00-15h45 - Magnetoelectric interfaces and ferroelectric tunnel junctions (2) E. Tsymbal (U. of Nebraska)
16h15-17h00 - Exchange coupling Y. Henry (Strasbourg)
17h00-18h30 - Laboratory visits (1) nanofabrication rooms or (2) physical measurements

THURSDAY FEBRUARY 21, 2008

9h30-11h00 - Scanning probe microscopies and magnetism (1+2) J.P. Bucher (Strasbourg)
11h30-12h15 - Low-dimensionality magnetism M. Drillon (Strasbourg)
12h15-13h00 - Talks of participants (1)

15h00 -16h00 - Talks of participants (2)
16h30-18h30 - Poster session

FRIDAY FEBRUARY 22, 2008

9h30-10h15 - Correlation effects in transport D. Weinmann (Strasbourg)
10h15-11h00 - New quantum transport phenomena in magnetic nanojunctions E. Tsymbal (U. of Nebraska)
11h30-13h00 - Laboratory visits (2) physical measurements or (1) nanofabrication rooms

15h00-16h30 - Microwave magnetism (1+2) M. Bailleul (Strasbourg)
17h00-17h45 - Femtosecond spin dynamics in semiconductors P. Gilliot (Strasbourg)
17h45-18h30 - Femtosecond magnetization dynamics of nanoparticles V. Halté (Strasbourg)

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EFFECTS OF BISMUTH SUBSTITUTION ON HEAVY RARE EARTH IRON GARNET

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Bismuth-substituted heavy rare-earth iron garnet materials have attracted much attention in optical communication industries due to their small temperature coefficient of Faraday rotation, low optical absorption, and a low magnetic field for saturation [1]. Especially, $(TbBi)_3Fe_5O_{12}$, and $(HoBi)_3Fe_5O_{12}$ have received much attention for the communication systems devices in the wavelength range of 1.3~1.6 μm [2].

Compunds of composition $Tb_{3-x}Bi_xFe_5O_{12}$ (x = 0.5, 0.75, 1.0, 1.25) and $Ho_2Bi_1Fe_5O_{12}$ were prepared using the sol-gel method. The crystallographic and magnetic properties of $Tb_{3-x}Bi_xFe_5O_{12}$ (x = 0.5, 0.75, 1.0, 1.25) and $Ho_2Bi_1Fe_5O_{12}$ powders were studied by using x-ray diffraction, vibrating sample magnetometer and Mössbauer spectroscopy. Crystal structure of the samples is determined to be normal cubic structure *Ia3d* by Rietveld refinement. The lattice constants increase linearly with increasing bismuth concentration in $Tb_{3-x}Bi_xFe_5O_{12}$ samples. These results accord with Vegard's law. The temperature dependence of magnetization with increasing bismuth concentration from x = 0.5 to x = 1.25 showed the decrease of compensation temperature from 177 to 107 K. Moreover, the field cooled magnetization of all samples show negative magnetization below the compensation temperature. We suggest that the negative magnetization is related to the local anisotropy by the strong covalent interaction between bismuth and iron. These results are shown in $Ho_2Bi_1Fe_5O_{12}$ system also. Mössbauer absorption spectra of $Tb_{3-x}Bi_xFe_5O_{12}$ (x = 0.5, 0.75, 1.0, 1.25) and $Ho_2Bi_1Fe_5O_{12}$ were taken at various tempertures from 4.2 to 700 K. The isomer shifts at room temperature of (16a) and (24d) site are around 0.26 mm/s and 0.04 mm/s, respectively, for all samples. The smaller isomer shifts of (24d) site than that of (16a) site means that the irons at (24d) site have a strong covalent interaction with bismuth. Although the nonmagnetic ion of bismuth substituted in TbIG, Néel temperature increased from 616 to 655 K with increase of bismuth concentration from x = 0.5 to x = 1.25 in $Tb_{3-x}Bi_xFe_5O_{12}$ system. Also, the saturation magnetization at room temperature is increase linearly with increase of bismuth concentration. These behaviors can be explained by strong exchange interaction between a-d sublattices with increase of bismuth concentration. Compare with results of $Tb_2Bi_1Fe_5O_{12}$, $Ho_2Bi_1Fe_5O_{12}$ has larger saturation magnetization, higher T_N, and lower coercivity than $Tb_2Bi_1Fe_5O_{12}$. These phenomena can be explained by influence of the Bi ions on the superexchange interaction between *a-d* sublattices.

References

[1] M. X. Xu, phys. stat. sol. (a), **170**, 175 (1998).
[2] G. Y. Zhang, X. W. Xu, and T. C. Chong, J. Appl. Phys., **95**(10), 5267 (2004).