Theoretical Study for realization of spintronics devices

Keywords: Magnetoresistance, Spin-orbit interaction, Surface/Interface, First-principles calculation

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Background

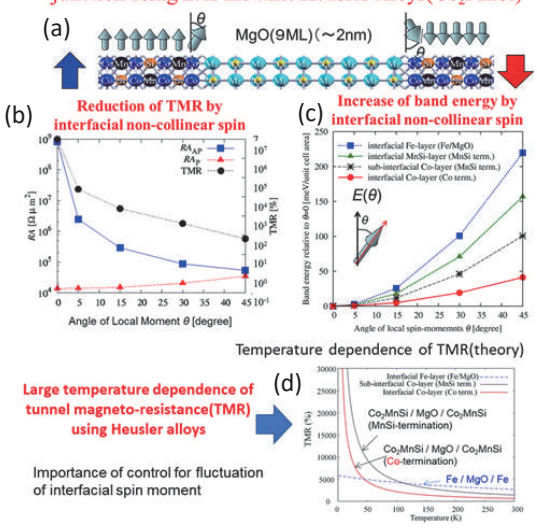
- Large temperature dependence of magneto-resistance effects in experiments
- Importance of interfacial spin-orbit interaction for functionality of spintronics devices
- Importance of microscopic theory of thermal spin effects
- Design of new materials for solving these problem

Aim

- Understanding of spin fluctuation effects on spin-dependent transport
- Theoretical design of heterojunction interfaces developing giant spin-orbit interaction
- Construction of microscopic theory for thermal spin effects
- Machine learning studies for design of new spintronics materials

Advanced Research Topics

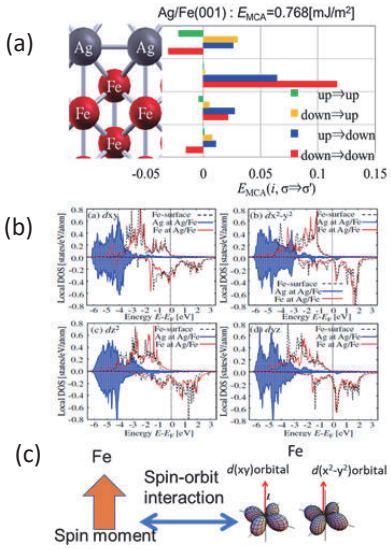
Temperature dependence of TMR of magnetic tunnel junction using half-metallic Heusler alloys(Co_2MnSi)



(a)Model for Co_2MnSi/MgO/Co_2MnSi, (b)TMR v.s. angle of interfacial spin, (c)energy v.s. angle of interfacial spin, (d)calculation of temperature dependence of TMR

Theoretical Study on magneto-crystalline anisotropy of Fe(001) interface

Contribution to magneto-crystalline anisotropy of interfacial atom (Second order perturbation analysis)



(a)Contribution of magneto-crystalline anisotropy of interfacial atom, (b)Local density of states of interfacial atoms, (c) relation between spin and orbital contributing perpendicular magnetic anisotropy

Publications

- Y. Miura et al., Phys. Rev. B **69**, 144413 (2004).
- Y. Miura, et al., Phys. Rev. B **83**, 214411 (2011).
- Y. Miura, et al., J. Appl. Phys. **113**, 233908 (2013).

Summary

- Spintronic device requires several physical properties such as large magnetoresistance, perpendicular magnetic anisotropy, low resistance.
- It is essential to control the magnetic properties at interfacial atomic layers from theoretical points of view.

Research outcome

- Design of magnetic hetero junctions showing magnetoresistance ratio of more than 1000% at room temperature
- Design of heterojunction interface developing giant spin-orbit interaction
- Design of new materials showing huge thermal spin effects