

Ji Shi, Associate Prof.

Department of Metallurgy and Ceramics Science

Research Highlights in 2007

- (1) The perpendicular magnetic anisotropy of CoPt/AlN layered structures

CoPt/AlN layered structures were found to show strong in-plane magnetic anisotropy in the as-deposited state. However, upon thermal annealing at temperatures between 400-600 C, perpendicular magnetic anisotropy with relative high anisotropy energy can be developed. The mechanism of such an anisotropy transition was studied. It has been found that there is strong compress stress inside the as-deposited films, which suppresses the surface (interface) anisotropy effect, and enhances the in-plane magnetic anisotropy of the film. When the films are annealed at temperatures above 400 C, the compressive stress is relaxed, and the surface anisotropy effect becomes dominant, perpendicular magnetic anisotropy is realized.

- (2) The magnetoresistance of Co-AlN and Co-TiO₂ nanocomposite films

The fabrication and characterization of Co-AlN and Co-TiO₂ nanocomposite films have been conducted. It has been found that by thermal annealing of co-deposited Co-Al-N films, granular structure of Co nano-particles distributed in AlN matrix can be formed. By adjusting the Co content in the film, magnetoresistance of 5% can be achieved at room temperature, and this magnetoresistance is originated from spin-dependent tunneling process. On the other hand, Co-Ti-O films were deposited with modulated oxygen content in the depth direction. After being thermal annealed at appropriate temperature, the films show very high resistivity and a magnetoresistance of up to 9% at room temperature. The mechanism resulting in the magnetoresistance is being studied.

Articles (original articles)

- 1 . Y. Hodumi, J. Shi, Y. Nakamura, Controlling the magnetic anisotropy in CoPt/AlN multilayer films, Applied Physics Letters, 90 212506 (2007) .
- 2 . Meifang Li, Ji Shi, Yoshio Nakamura, and Ronghai Yu, Magnetoresistance of nanocrystalline Co-AlN films, Applied Physics A 89, 807-812 (2007).

3. Takashi Harumoto, Ji Shi, and Yoshio Nakamura, X-Ray Reflectivity Studies of Pt/AlN Multilayered Films, Materials Science Forum, 561-565, 2095-2098 (2007).
4. Shinji Muraishi, Hirono Naito, Ji Shi, Yoshio Nakamura, Tatsuhiko Aizawa, Controlled Elasticity in Nano-structured Metallic Glass by Ion Implantation method, Materials Science Forum, 561-565, 1315-1318 (2007).

Presentations at International conferences

1. Ji Shi, Tomio Ohtsuki, Yoshio Nakamura, Magnetoresistance of Oxygen-concentration modulated Co-Ti-O Layered Structure, International Conference on Nanoscience and Technology, July 2-6, 2007 Stockholm, Sweden.
2. Kenji Makihara, Mituru Hashimoto, Ji Shi, Yasuhito Zohta, Growth Structure of Co Films on GaAs(100) Covered with MgO Buffer By RF Sputtering, International Conference on Nanoscience and Technology, July 2-6, 2007 Stockholm, Sweden.
3. Takashi Harumoto, Ji Shi, and Yoshio Nakamura, X-Ray Reflectivity Studies of Pt/AlN Multilayered Films, The Sixth Pacific Rim International Conference on Advanced Materials and Processing, Nov. 5-9, 2007, Jeju Island, Korea.
4. Shinji Muraishi, Hirono Naito, Ji Shi, Yoshio Nakamura, Tatsuhiko Aizawa, Controlled Elasticity in Nano-structured Metallic Glass by Ion Implantation method, The Sixth Pacific Rim International Conference on Advanced Materials and Processing, Nov. 5-9, 2007, Jeju Island, Korea.
5. Y. Nakamura, J. Shi, Y. Hodumi, T. Harumoto, Perpendicular Magnetic Anisotropy of Co-Pt Ultra Thin Films Confined by AlN Nitride, Northeastern Asian Symposium on Advanced Materials 2007, Dec. 5-9, 2007, Beijing China.

Joint research

Joint researches are being conducted with researchers in Tsinghua University and Dalian University of Technology in China.