

Strategic Young Researcher Overseas Visits Program
for Accelerating Brain Circulation 2011

**“Development of Young Researchers
Based on International Joint Research
on Green Energy Systems”
Progress Report**

1. Name: Takeshi Yanai
2. Title: Assistant Professor
3. Host Institution: Monash University (Australia)
4. Host Researcher: Professor Kiyonori Suzuki
5. Duration: 25-Mar-2012 – 24-Mar-2013
6. Research Topic: Magnetic Materials
7. Overview of the Results of the Collaborative Research:

We prepared Fe-Ni films in organic-acid-based baths and evaluated their magnetic and structural properties. It is found that the Fe content of the film depends markedly on the acid concentration and low coercivity values of less than 30 A/m were realized at around 22 at.% of Fe. This magnetic softness is attainable in a wide range of film thickness between 20 and 150 μm . Cathode efficiencies of Fe-Ni films with Fe content of 22 at.% were approximately 80 % for each bath. Furthermore, high deposition rates of approximately 200 $\mu\text{m}/\text{h}$ were obtained by increasing the current density during the deposition. From these results, we concluded that the organic-acid-based baths are environmentally friendlier plating baths and suitable for mass-production of magnetically soft Fe-Ni films.

8. Deployment Plans for Future Collaborative Research:

We mainly researched on soft magnetic materials in the period and have reported some peer-reviewed papers. Our next target is hard magnetic materials and we will propose a fabrication process of films for hard magnetic materials.

9. List of Collaborative Research Progress:

Publication(s)

1. T. Yanai, K. Shiraishi, Y. Watanabe, T. Ohgai, M. Nakano, K. Suzuki, and H. Fukunaga, "Magnetic Fe-Co films electroplated in a deep-eutectic-solvent-based plating bath", *Journal of Applied Physics*, Vol. 117, No.17, 2015.5, #17A925.
2. T. Yanai, K. Furutani, T. Ohgai, M. Nakano, K. Suzuki, and H. Fukunaga, "Fe-Pt thick-film magnets prepared by electroplating method", *Journal of Applied Physics*, Vol. 117, No.17, 2015.5, #17A744.
3. R. Parsons, T. Yanai, H. Kishimoto, A. Kato, M. Ohnuma, and K. Suzuki, "Induced magnetic anisotropy in Si-free nanocrystalline soft magnetic materials: A transmission x-ray diffraction study", *Journal of Applied Physics*, Vol. 117, No.17, 2015.5, #17A333.
4. Y. Watanabe, T. Yanai, M. Otsubo, A. Takahashi, T. Ohgai, M. Nakano, K. Suzuki, H. Fukunaga, "Improvement in current efficiency of electroplated Fe-Ni films prepared in citric-acid-based baths", *Journal of Applied Physics*, Vol. 117, No.17, 2015.5, #17A326.
5. T. Yanai, K. Shiraishi, Y. Watanabe, M. Nakano, T. Ohgai, K. Suzuki, and H. Fukunaga, "Electroplated Fe-Ni films prepared from deep eutectic solvents", *IEEE Transactions on Magnetics*, Vol.50, Issue 11, 2014.11, #2008404.
6. T. Yanai, K. Shiraishi, T. Shimokawa, Y. Watanabe, T. Ohgai, M. Nakano, K. Suzuki and H. Fukunaga, "Electroplated Fe films prepared from a deep eutectic solvent", *Journal of Applied Physics*, Vol. 115, No.17, 2014.5, pp. 17A344-1□3.
7. T. Yanai, T. Shimokawa, Y. Watanabe, T. Ohgai, M. Nakano, K. Suzuki and H. Fukunaga, "Effect of current density on magnetic properties of electrodeposited

- Fe-Ni films prepared in a citric-acid-based-bath”, *Journal of Applied Physics*, Vol. 115, No.17, 2014.5, pp. 17A325-1□ 3.
8. T. Yanai, T. Shimokawa, Y. Watanabe, M. Nakano, K. Suzuki and H. Fukunaga, “Electrodeposited Fe-Ni films prepared in a citric-acid-based bath with different pH values”, *IEEE Transactions on Magnetics*, Vol. 50, No. 1, 2014.1, pp. 2000703-1□ 3.
 9. T. Yanai, H. Uto, T. Shimokawa, M. Nakano, K. Suzuki and H. Fukunaga, “Electrodeposited Fe-Co films Prepared from a Citric-acid-based Plating Bath”, *Journal of the Korean Physical Society*, Vol. 62, No. 12, 2013.6, pp. 1966-1968.
 10. T. Shimokawa, T. Yanai, K. Takahashi, M. Nakano, K. Suzuki and H. Fukunaga, “Electrodeposited Fe-Ni Films Prepared from a Tartaric-acid- based Bath”, *Journal of the Korean Physical Society*, Vol. 62, No. 12, 2013.6, pp. 1963-1965.
 11. T. Shimokawa, T. Yanai, K. Takahashi, M. Nakano, K. Suzuki, and H. Fukunaga, “Soft Magnetic Properties of Electrodeposited Fe-Ni Films Prepared in Citric Acid Based Bath”, *IEEE Transactions on Magnetics*, Vol. 48, No.11, 2012.11, pp. 2907□ 2909.

Conference Presentation(s)

1. R. Parsons, T. Yanai, H. Kishimoto, A. Kato and K. Suzuki, “Effect of Si on the field-induced magnetic anisotropy in Fe-rich nanocrystalline soft magnetic materials”, in The 58th Annual Magnetism and Magnetic Materials Conference (2013.11).
2. T. Yanai, T. Shimokawa, Y. Watanabe, M. Nakano, K. Suzuki, H. Fukunaga, “Magnetic properties of Fe films prepared from a deep eutectic solvent”, in The 58th Annual Magnetism and Magnetic Materials Conference (2013.11).
3. T. Shimokawa, T. Yanai, Y. Watanabe, M. Nakano, K. Suzuki, H. Fukunaga, “Effect of current density on magnetic properties of electrodeposited thin Fe-Ni films prepared in a citric-acid-based bath”, in The 58th Annual Magnetism and Magnetic Materials Conference (2013.11).
4. T. Yanai, T. Shimokawa, M. Nakano, K. Suzuki, H. Fukunaga, "Electrodeposited Fe-Ga Films", in The 3rd International Symposium on Advanced Magnetic Materials and Applications (2013.7).

5. T. Yanai, T. Shimokawa, Y. Watanabe, M. Nakano, K. Suzuki and H. Fukunaga, "Electrodeposited Fe-Ni films prepared in a citric-acid-based bath with different pH values, in The 3rd International Symposium on Advanced Magnetic Materials and Applications (2013.7).
6. T. Yanai, T. Kawaguchi, M. Nakano, K. Suzuki and H. Fukunaga, "Electrodeposited Fe-Ga films prepared from citric acid based bath", in The 2nd International Conference of The Asian Union of Magnetic Societies (2012.10).
7. T. Yanai, H. Uto, T. Shimokawa, M. Nakano, K. Suzuki and H. Fukunaga, "Electrodeposited Fe-Co film prepared from citric acid-based plating bath", in the 19th International Conference on Magnetism (2012.5).
8. T. Shimokawa, T. Yanai, K. Takahashi, M. Nakano, K. Suzuki and H. Fukunaga, "Investigation of electrodeposited FeNi film prepared from tartaric acid based bath", in the 19th International Conference on Magnetism (2012.5).
- 9.