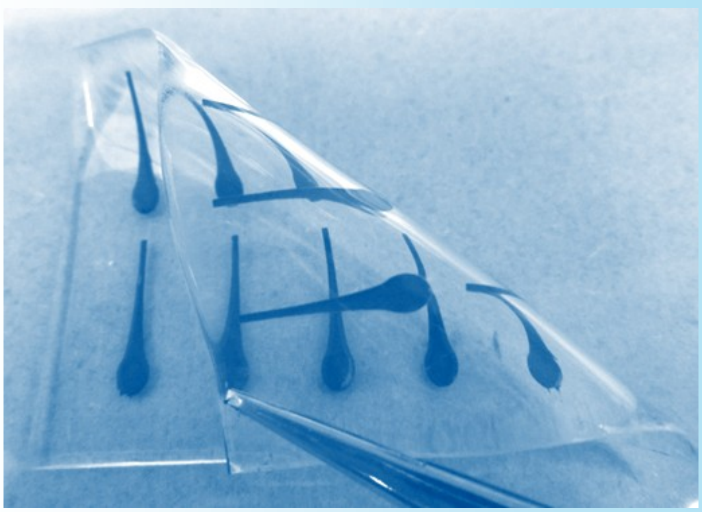
August 2012 Issue

IEEE NTC NEWSLETTER



Inside this issue:

Dear Readers,

Welcome to the second issue of the IEEE NTC Nanotechnology Newsletter for 2012. It has been our goal to bring forth the latest research trends and upcoming events in nanotechnology. We hope to continue our efforts in this endeavour.

We look forward for your valuable feedback and continued readership.

Sincerely,
NTC Newsletter Team

Editor-in-Chief

Prof. John T. W. Yeow,
Department of Systems Design Engineering,
University of Waterloo,
Ontario, Canada.
Email: **jyeow@uwaterloo.ca**

IEEE Nanotechnology Council

President
Stephen M. Goodnick

Past-President
Ning Xi

Vice President of Conferences
Wen J. Li

Vice President of Finance
Xiaoping Yun

Vice President of Publications
Aristides Requicha

Vice President of Technical Activities
Andy Chung

Secretary
Edward G. Perkins

Awards Chair
James Morris

EIC Transactions on Nanotechnology
Kang Wang

EIC of Nanotechnology Magazine
Wen J. Li

NTC Newsletter Editing Team (University of Waterloo, Canada)

Manu Pallapa
Shruti Nambiar

Magnetic nanoparticle doped nano-patternable polymers

Ajit Khosla, PhD

School of Engineering Science, Simon Fraser University, Burnaby, B,C, Canada, V5A 1S6

Introduction

Magnetic materials can be broadly classified in two categories; *soft magnetic materials* and *hard magnetic materials***.** Soft magnetic materials (such as Iron, Nickel) are easy to magnetize and demagnetize. They retain very less or no magnetism after the removal of applied magnetic field. This is because the domain wall movement in soft magnetic field is very easy. However, hard magnetic materials (such as Cobalt, magnetite, Neodymium Iron Boron alloy, Samarium Cobalt) retain their magnetism and are difficult to demagnetize. These materials retain their magnetism even after the removal of the applied magnetic field. Hard magnetic materials are therefore, used for making permanent magnets. The domain wall movement in case of hard magnetic materials is very small, hence they retain magnetism.

Hard as well as soft magnetic materials are used in computers, motors, cell phones, hybrid cars, lasers, MRI equipment, aerospace components, automotive, magnetic gaskets, actuators, position sensors, portable X-Ray systems, toys, and many other consumer, lab on a chip, and medical devices.

Over a last decade there has been a big thrust to use magnetic materials in Nano-Micro-electromechanical Systems (N-M-EMS). Cugat et al., in 2003 reported a thorough analysis of the benefits of electro-magnetic interactions in MEMS [1]. Various magnetic materials based N-M-EMS devices have been fabricated such as microvalves, microcoils, micro inductors, reed switches, chemical and biological sensors and systems [2]. The most common processing methods involved in fabricating magnetic MEMS devices are sputtering and electroplating. These processes although standard in processing technology for N-M-EMS do not work very well for hard magnetic materials as the sputtered magnetic material (such as NdFeB) needs to wet chemically etched and then undergo vacuum heat treatments (sintering). In case of NdFeB heat treatment at 750-1090°C for 2-4 hours has been reported in order to fabricate good film with high energy product [3]. Such high temperatures are not suitable for ether silicon or polymer N-M-EMS processing technology.

Furthermore, If metals or alloys are deposited on PDMS, the weak adhesion between them and polymers (such as SU-8 and Silicone) leads to microcracks when the substrates are flexed, bent, or twisted.

Overcoming challenges

In order to elevate the problem of microcracks appearing on sputtered metals on polymer surfaces such as silicone, it is important to develop silicone-based active materials of similar flexibility to the undoped and insulating silicone, so that they can also be easily micromolded using soft lithography techniques. In 2009, Prof. B. L. Gray and her team, from Simon Fraser University, defined a general fabrication process of magnetic nanoparticle doped silicone based polymers which can be easily nano-micro patterened. The choice of polymer was polydimethylsiloxane (PDMS) which silicone based two part elastomer. They employed the use of rare earth magnetic MQFP D15 powder in order to fabricate micro magnets [5]. The fabrication of novel magnetic nanoparticle doped polymer nanocomposite is a four step process which involves 1) Dispersing the desired type and quantity of type nanoparticles in an organic solvent such as heptane or toluene, via high frequency ultrasonics (24 kHz) employing a horn tip probe in pulse mode (10 seconds on and 15 seconds off) for a total time of two minutes. 2) The base elastomer/monomer is added to the magnetic nanoparticle- organic solvent emulsion, followed by high frequency agitation. 3) The polymer curing/crosslinking agent is added in ratio of 10:1; i.e., 10 parts of base elastomer and one part of curing agent. It is important to add curing agent "after" high frequency ultrasonic process as a lot of heat is produced during ultrasonication process, which cans tart to solidify (cure) the magnetic nanocomposite during mixing. 4) The prepared PDMS based nanocomposite is shear mixed until the heptane evaporates. Evaporation of organic solvent from PDMS nanocomposite may be determined visually, by weight, or by calculating volume of the nanocomposite [4].

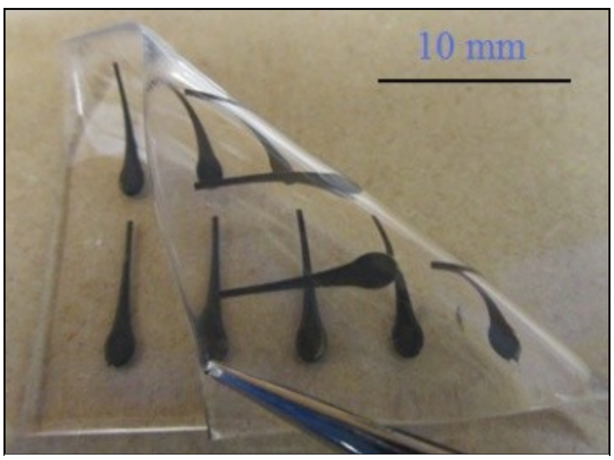


Fig. 1 Polymer bonded permanent magnets patterned on a non magnetic flexible transparent polymer substrate

Note that ultra-sonication should be carried out using an ultrasonic probe and not in an ultrasonic bath. The prepared magnetic nanocomposite placed into a vacuum chamber to remove air bubbles for 30 minutes and poured on to a micromold which can be fabricated using SU-8 or PMMA and degassed for ten minutes [5]. Excess magnetic nanocomposite can be easily scraped off using the Damascene-like process from the surface of the mold using surgical knife Undoped PDMS polymer was then poured on the surface and degassed. The silicon substrate is then kept on a hotplate at 75 ^{0}C for 2 hour and then peeled off from the mold. Figure 1 and 2 show examples of fabricated different PDMS based magnetic nanocomposite polymers on flexible undoped PDMS.

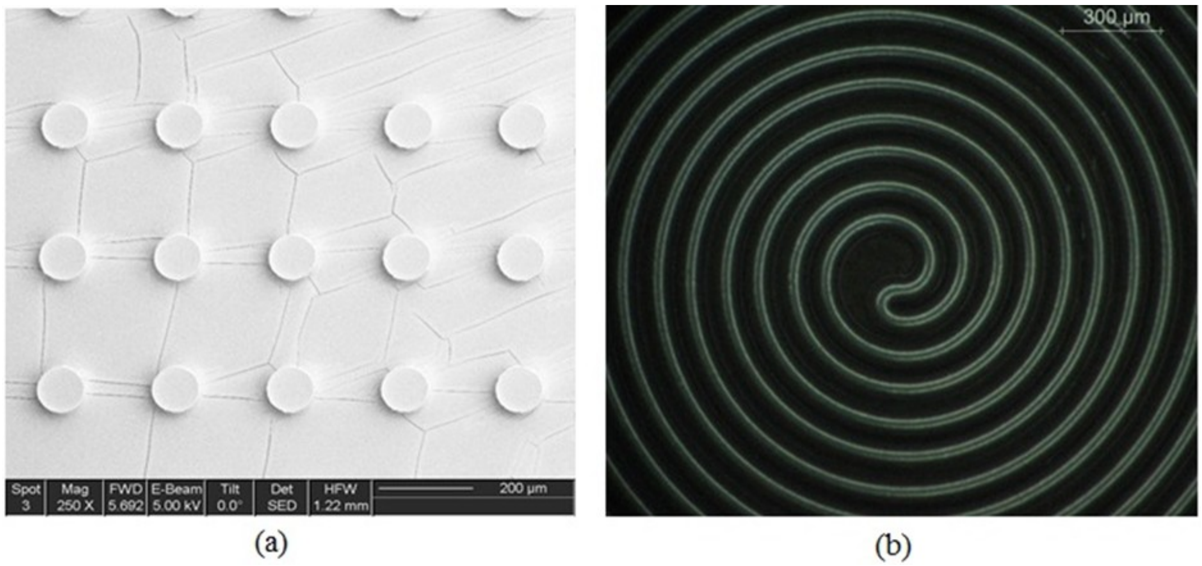


Figure 2 SEM and optical micrograph of: a) NdFeB micromolded hard micromagnets; b) 50nm nickel nanoparticle doped PDMS microcoils.

Conclusion

The developed magnetic nanocomposite polymers allows manufacture of flexible PDMS based active N-M-EMS devices and over the material mismatch and sintering issues. However, It is important to determine the smallest feature size, aspect ratio, and resolution, of the fabricated magnetic nanocomposites. This is highly dependent on the nanoparticle size used to fabricate the manetic nanocomposites and also how well they can be nano- mold. However, it has been reported that unfilled PDMS has been micromolded with features smaller than 50 nm, so we expect that our nanomaterials may be employed for features less than one micrometer, provided sufficiently small nanoparticles used.

Acknowledgements

The author would like to thank Prof B. L Gray for her support and Dr. J. W. Herchenroeder Vice-President; Magnaquench Inc, for ongoing support to Magnetics MEMS research program.

References:

[1] O. Cugat, J. Delamare, and G. Reyne, "Magnetic micro-actuators and systems (MAGMAS)," IEEE Trans. Magn., vol. 39, no. 5, pp. 3607–3612, Nov. 20, 2003

[2] M. N. Dempsey; A. Walther; F. May; et al., "High performance hard magnetic NdFeB thick films for integration into micro-electro-mechanical systems," Applied Physics Letters , vol.90, no.9, pp.092509-092509-3, Feb 2007

[3] A. Khosla, and B. L. Gray; "Micropatternable Multifunctional Nanocomposite Polymers for Flexible Soft NEMS and MEMS Applications" ECS Trans. 2012 volume 45, issue 3, 477-494.

[4] http://www.mqitechnology.com/

[5] A. Khosla and B. L. Gray, "New technologies for large-scale micro-patterning of functional nanocomposite polymers", Proc. SPIE 8344, 83440W (2012)

About the Author

Dr. Ajit Khosla is a research engineer at School of Engineering Science, Simon Fraser University Canada. He is an executive committee member of Sensor Division of Electro-Chemical Society, since 2010 and also is a program committee member of SPIE - The International Society for Optical Engineering: Smart Structures and Materials-NDE: Nano-, Bio-, Info-Tech Sensors and Systems (Conference 8344). He is also an active IEEE-EDS and has various technical meetings. His area of expertise and research interest include Sensors, MEMS, NEMS, Nanocomposites, Magnetics, Flexible electronics, Polymer electronics, Solar Cells, Smart Garments, Nano-Bio technology in medicine and engineering. He has over 61 academic contributions since 2008 , which include: 3 patents, 1 keynote lecture, 5 journal papers, 5 transaction papers, 1 technical magazine article, 32 conference papers, 12 invited talks and 1 book chapter.

Awards – Call for nominations

For the three individual awards, all nomination materials, including reference letters, must reach the NTC Awards Committee by October 15th each year. Nominees must be IEEE members. For the Chapter award, all nomination materials must reach the NTC Awards Committee by March 31st each year. See the Call for Nominations page for details on the process and to download the forms.

1. PIONEER AWARD IN NANOTECHNOLOGY

Description: The NTC Pioneer Award in nanotechnology is to recognize individuals who by virtue of initiating new areas of research, development or engineering have had a significant impact on the field of nanotechnology. The award is intended for people who are in the mid or late portions of their careers, i.e., at least 10 years beyond his or her highest earned academic degree on the nomination deadline date. Up to two awards may be given per year. There may be one award for **academics** (persons employed by colleges or universities) and one for persons employed by **industry or government** organizations.

The award consists of $1000 ($500 each if two awards are made) honorarium and a commemorative plaque.

2. EARLY CAREER AWARD IN NANOTECHNOLOGY

Description: The Nanotechnology Council has established an Early Career Award to recognize individuals who have made contributions with major impact on the field of nanotechnology. Up to two awards may be given per year. There may be one award for **academics** (persons employed by colleges or universities) and one for persons employed by**industry or government** organizations.

The award consists of $1000 ($500 each if two awards are made) honorarium and a commemorative plaque.

3. DISTINGUISHED SERVICE AWARD

Description: Nanotechnology Council to establish a Distinguished Service Award to recognize an individual who has performed outstanding service for the benefit and advancement of Nanotechnology Council.

The award consists of $1000 honorarium and a commemorative plaque.

4. CHAPTER OF THE YEAR AWARD

All nomination materials must reach the NTC Awards Committee by March 31st each year.

Nominations may be made by any full IEEE member, or by a representative of the nominee chapter.

Description. The IEEE Nanotechnology Council (NTC) Chapter of the Year Award is intended to encourage a successful and effective overall performance of the Chapter in terms of its activities. Exemplary Chapters must have a high number of activities and creativity. The Chapter must consistently be active in organizing activities throughout the year.

The award consists of $500 and a certificate.

IEEE Nanotechnology Materials and Devices Conference

Conference Scope

- Graphene and Nanotube Based Materials and Devices
- Materials and Devices for Nanoelectronics, Nano-Optics
- Materials and Devices for Bio-Medical Applications
- Bio-Fluidics and Integrated Bio-Chips
- MEMS/NEMS for Bio-Nanotechnology
- Materials and Devices for Energy and Environmental Applications
- Structural Application of Nanomaterials and Nano-Coatings
- Characterization and Simulation of Nanomaterials and Nanostructures
- Standards and Safety Issues of Nanotechnology

Honorary General Chair
Yoon-Ha Jeong, Postech, Korea

General Chair
Wen J. Li, City Univ. of Hong Kong, Hong Kong
Co-Chairs:
Stephen Goodnick, Arizona State Univ., USA
Osamu Tabata, Kyoto Univ., Japan

Organizing Chair
John D. Mai, ITRI, Taiwan

Technical Program Chair
Meyya Meyyappan, NASA Ames, USA
Co-Chair
Zhidong Wang, Chiba Inst. of Tech., Japan

Important Deadlines

2-Page Abstract Due: **April 30, 2012**
Notification of Acceptance: **May 31, 2012**
Full Paper* (4 to 6 Pages) Due: **June 30, 2012**
Early Bird Registration: **July 05, 2012**

***Accepted Full Papers will be published on the IEEE Xplore database and EI-Indexed.**

Student's Corner

Upcoming Conferences:

INEC — 2013 IEEE International Nanoelectronics Conference

Dates: 02 Jan 2013 → 04 Jan 2013

Location: Singapore, Singapore

http://www.inec2013.org/index.html

IEEE MEMS 2013 — 26th International Conference on Micro Electro Mechanical Systems

Dates: 20 Jan 2013 → 24 Jan 2013

Location: Taipei, Taiwan

http://www.mems2013.org/

AMN — Advances in Microfluidics & Nanofluidics

Dates: 24 May 2013 → 26 May 2013

Location: Notre Dame, United States

http://www.amn2013.org

ICN+T 2013 - International Conference on Nanoscience and Technology

Dates: 09 Sep 2013 → 13 Sep 2013

Location: Paris, France

http://www.icnt2013.com/

MEMS — 2014 IEEE 27th International Conference on Micro Electro Mechanical Systems

Dates: 26 Jan 2014 → 30 Jan 2014

Location: San Francisco, CA, United States

http://www.mems2014.org