

# BISWAJIT SAHA

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## EDUCATION

PhD:	2007 – 2011 Mechanical and Aerospace Engineering (on Material) Singapore MIT Alliance (National University of Singapore - Singapore Nanyang Technological University – Singapore Massachusetts Institute of Technology – USA)
MTech:	2005 - 2007 Chemical Engineering Department Indian Institute of Technology; Kharagpur - India
BTech:	2001 - 2005 Chemical Engineering Department National Institute of Technology; Durgapur - India

## EMPLOYMENT HISTORY

contract Assistant Professor:	March, 2014 – Present Mechanical and Aerospace Engineering, Seoul National University, Seoul, South Korea
Scientist:	Sept, 2011 – July 2013 Color cosmetic (R&D) Procter and Gamble (P&G), Kobe, Japan

## RESEARCH EXPERIENCE

Research interest: Biodegradable and wearable electronics, Biosensor, Microfluidic device fabrication, Smart farming

### Major research achievement:

- i. Biodegradable and wearable electronics:
  - Developed novel printing paper based strain sensors utilising reduced graphene oxide (rGO), which have a gauge factor of about  $66.6 \pm 5$ . They exhibit bending and folding

- detection limits of 0.2° and 0.1°, respectively, which are smaller than those of any other graphene sensors.
- Developed cellulose, graphene and PDMS based soft composite material that are highly sensitive to deformation.
  - Applied above strain sensors for the detection of various human motions, including finger, knee and wrist movements. In addition, rGO sensors were used to develop a prototype device for tracking the gestures of a robotic hand and a touch-sensitive paper keyboard.
- ii. Biosensor:
- E.coli are successfully encapsulated by magnetic nanoparticles and manipulated their movement under magnetic field.
  - For the first time, we have successfully demonstrated spontaneous detection of magnetic particles encapsulated E.coli by rGO FET sensor in less than 1 min.
- iii. Microfluidic device fabrication:
- Established fundamental relationship between bond structure, morphology and surface properties of various hard thin film coating with their tribological behavior.
  - Successfully fabricated micro/nano and high aspect ratio structure by hot-embossing and injection molding using coated mold.
  - Studied and improved lifetime of Si and metal Microsystems by diamond-like carbon (DLC), ceramic and self-assembled monolayer (SAM) thin film coatings.
  - Evaluated the tribological (lubricant, wear and friction) performance and failure mechanism of coated micro-molds and optimized the coating process parameters design of experimental method (DOE) based on surface and tribological properties.
- iv. Smart farming:
- Developed capacitance based soil moisture sensor that can measure change of water contain less than one percentage.
  - Developed nano-crack based multifunctional rGO-PDMS strain sensors by depositing tough reduced graphene oxide (rGO) on elastomeric polydimethylsiloxane (PDMS)
- v. In industry (Procter and Gamble):
- Robust emulsion system had been formulated to improve stability and efficacy of cosmetic products.
  - Despite having challenges in heat transfer and mixing process of making process, a cosmetic product was successfully scale-up from lab scale to production scale.

## ACHIEVEMENT AND SKILL

### Membership:

- Co-organizer and session chair of SPARCA 2017 – Japan conference
- Co-organizer of ISAMR 2017 – Taiwan conference
- Board member of ICAET Conference
- Reviewer of “Journal of Micromechanics and Microengineering”
- Reviewer of “Sensors and Actuators B” journal
- Reviewer of “Wear” journal
- Reviewer of “Tribology International” journal

**Award:**

- Best innovative idea award: by Defense Acquisition Program Administration (DAPA) , South Korea 2017
- Keynote speaker: by SPARCA conference, 25-28<sup>th</sup> February 2017, Okinawa, Japan
- Most read paper of the month: by Journal paper on strain sensing – February 2017
- Invited speaker: by ISAMR conference, 11-14<sup>th</sup> August 2016, Taiwan
- Invited speaker: by ISAMR conference, 16-20<sup>th</sup> August 2015, Taiwan
- Highlights collection of paper 2016: by Journal of Micromechanics Microengineering
- Silver Award on Power of People (Twice): by P&G 2012 March & July
- Best poster presentation: by Singapore-MIT alliance 2011
- Best poster presentation: by Singapore-MIT alliance 2009
- Prestigious SMA PhD scholarship: by Singapore-MIT alliance 2007 ~ 2011

**Skill in instrument:**

3D printing, Sputtering coating, Hot-embossing, Injection molding, Scanning electron microscopy (SEM), Energy dispersive X-ray spectroscopy (EDS), X-ray photoelectron spectroscopy (XPS), Confocal microscopy, X-ray diffraction spectroscopy (XRD), Atomic force microscopy (AFM), Fourier transform spectroscopy (FTIR), Raman Spectroscopy, Goniometer, Confocal microscopy, Nanoindenter, Scratch tester, Thermal gravimetric analysis (TGA), Dynamic mechanical analysis, Spin coater, Tribometer, LCR meter, MTS

**PUBLICATION**

***Book chapter:***

1. B. Saha, E. Liu, S. B. Tor; “Nanotribological phenomena, principles and mechanisms for MEMS”, Book- “Nano-tribology and Materials in MEMS” publisher- Springer, 2013.

***Keynote speaker:***

1. B Saha, Printing paper – A biodegradable strain sensor, Symposium for the Promotion of Applied Research Collaboration in Asia (SPARCA), 25-28<sup>th</sup> February 2017, Okinawa, Japan. Organized by: Asia Pacific Society for Materials Research

***Invited speaker:***

1. B. Saha; “Surface coating: A solution for micro/nano fabrication by hot-embossing and injection molding”, International symposium for advance materials research (ISAMR); 16-20<sup>th</sup> August 2015, Taiwan. Organized by: Asia Pacific Society for Materials Research
2. B Saha, P. Purwar, J. Lee, Reduced graphene oxide based biosensor for detection of pH and bacteria, International symposium for advance materials research (ISAMR); 11-14<sup>th</sup> August 2016, Taiwan. Organized by: Asia Pacific Society for Materials Research
3. B Saha, P. J. Lee, Paper-based wearable sensor and biomimetic robot to assist soldier in battlefield, International Military Science and Technology Fair, 20-23 July 2017, COEX Seoul, South Korea. Organized by: Defense Acquisition Program Administration

***Journal paper:***

1. B. Saha, E. Liu, S. B. Tor, N. W. Khun, D. E. Hardt, J. H. Chun; Anti-sticking behavior of DLC-coated silicon micro-molds, *J. Micromech. Microeng.* 19 (2009) 105025.
2. B. Saha, E. Liu, S. B. Tor, N. W. Khun, D. E. Hardt, J. H. Chun; Replication performance of Si-N-DLC-coated Si micro-molds in micro-hot-embossing, *J. Micromech. Microeng* 20 (2010) 045007.
3. B. Saha, E. Liu, S. B. Tor, D.E. Hardt, J. H. Chun, N.W. Khun; Improvement in lifetime and replication quality of Si micromold using N: DLC: Ni coatings for microfluidic devices, *Sensors and Actuators B: Chemical* 150 (2010) 174–182.
4. B. Saha, S. B. Tor, E. Liu, D. E. Hardt, J. H. Chun; Hot-embossing performance of silicon micromold coated with self-assembled n-octadecyltrichlorosilane, *Sensors and Actuators B: Chemical*, 160 (2011) 207-214.
5. B. Saha, E. Liu, S. B. Tor, D. E. Hardt, J. H. Chun; Modification of surface properties of silicon micro-molds by nitrogen and silicon doped diamond-like carbon coatings deposited with magnetron co-sputtering, *Vacuum* 85 (2012), 1105-1107.
6. B. Saha, S. B. Tor, E. Liu, D. E. Hardt, J. H. Chun; Titanium–aluminum–polytetrafluoroethylene coated stainless steel micromold via co-sputtering deposition: Replication performance and limitation in hot-embossing, *Sensors and Actuators B: Chemical*, 163 (2012) 290-298.
7. B. Saha, M. Dirckx, D. E. Hardt, S. B. Tor, E. Liu, J. H. Chun; Effect of sputtering power on friction coefficient and surface energy of co-sputtered titanium and molybdenum disulfide coatings and its performance in micro hot-embossing, *Microsystem Technologies*; 20 (2014) 1069-1078.
8. B. Saha, J. Lee; Improvement of Surface Properties of Micro-Mold via SAM Coating for Fabrication of Microfluidic Device, *Applied Mechanics and Materials Vols. 752-753* (2015) pp 159-162.
9. B. Saha; W. Toh; E. Liu; S. B. Tor; D. E. Hardt; J. Lee; A review on the importance of surface coating of micro/nano-mold in micro/nano-molding processes, *J. Micromech. Microeng*, Article reference: 26 (2015) 013002 (40pp)
10. Saha Biswajit; Toh Wei; Liu Erjia; Tor Shubeng; Lee Junghoon; A study on frictional behavior of PMMA against FDTS coated silicon as a function of load, velocity and temperature, *Tribology International*, 102 (2016) 44-51
11. B Saha, S Baek, J Lee; Highly Sensitive Bendable and Foldable Paper Sensors Based on Reduced Graphene Oxide, *ACS Applied Materials & Interfaces*; 9 (5) (2017), 4658–4666
12. B Saha, P. Purwar, J Lee; Spontaneous Detection of Bacteria by Reduced Graphene Oxide using Magnetic Nanoparticle Encapsulation Methodology, (submitted;)
13. B Saha, J Lee; A biomimetic strain sensor of reduced graphene oxide on PDMS, in progress

***Technical conference:***

1. B. Saha, N. W. Khun, S. B. Tor, E. Liu, D. E. Hardt, J. H. Chun; Structural and Tribological Properties of DLC Coatings Synthesized by dc Magnetron Cosputtering, 7<sup>th</sup> International Conference on Materials Processing for Properties and Performance; 5-7<sup>th</sup> November 2008 Paper ID: AMFT-7037.
2. B. Saha, S. B. Tor, E. Liu, D. E. Hardt, J. H. Chun; Improvement of Replication of Patterns by Using With Anti-sticking DLC Coating Micromolds, The SMA 10<sup>th</sup> Anniversary Symposium 21-22 January (2009) Parallel Session 2, Page 74.

3. B. Saha, S. B. Tor, E. Liu, D. E. Hardt, J. H. Chun; Improvement on Micro-mold Life and Duplication Quality via DLC Coatings, SMA symposium 19<sup>th</sup> January 2010; Singapore.
4. B. Saha, E. Liu, S. B. Tor, D. E. Hardt, J. H. Chun; Modification of surface properties of silicon micro-molds by nitrogen and silicon doped diamond-like carbon coatings deposited with magnetron co-sputtering, 11<sup>th</sup> European Vacuum Conference (2010) 20-24<sup>th</sup> September, Spain, University of Salamanca, Historical building, Patio escuelas menores 1.
5. B. Saha, S. B. Tor, E. Liu, D. E. Hardt, J. H. Chun; A rigorous study on capability of OTS coating in hot-embossing process for fabrication of microfluidic device, SMA symposium 12<sup>th</sup> January 2011; Singapore.
6. B. Saha, S. B. Tor, E. Liu; Ti-Al-PTFE Anti-sticking Coatings, Thin Films Workshop; 13 -16 July 2013; Chongqing river cruise; China.
7. B. Saha, E. Liu, S. B. Tor, J. Lee; N:DLC:Ni antisticking coating for micromold, Surface Modification Technology (SMT-28); Tampere University of Technology, Finland; 16-18<sup>th</sup> June, 2014.
8. B. Saha, J. Lee; Improvement of surface properties via SAM coating for fabrication of microfluidic device; ICAET, 20-22 December 2014; Incheon, South Korea.
9. S. Lee, B. Saha, J. Lee; Cell motility regulation on stepped micro pillar array device (SMPAD) with discrete stiffness gradient, IEEE MEMS; 18-22 January 2015, Estoril; Portugal.
10. B. Saha, J. Lee; An experimental study on fabrication of polymeric microfluidic device using diamond-like carbon coated silicon micro-molds, KSEM, 20-22 May 2015, Busan, Korea.
11. B. Saha, J. Lee; Direct patterning of reduced graphene oxide sensors for detection of bacteria, NanoBioTech, 7-9<sup>th</sup> November 2016, Montreux, Switzerland.

Technical poster:

1. B. Saha, S. B. Tor, E. Liu, D. E. Hardt, J. H. Chun; The SMA 10<sup>th</sup> Anniversary Symposium 2009.
2. B. Saha, S.B.Tor, E. Liu, D. E. Hardt, J. H. Chun; SMA Symposium 2010.
3. B. Saha, S. B. Tor, E. Liu, D. E. Hardt, J. H. Chun; SMA Symposium 2011