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A newsletter about micro and smart systems in India

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## Highlights of the conference

- Full-paper peer review to ensure the technical quality of the conference.
- Five plenary talks that touched upon not only the micro and smart but also nano and bio aspects.
- A special common session on India's micro foundries (see p. 5).
- A common poster session that emphasized the interaction (see p. 4).
- A student paper contest with the best student paper award (see p. 7).
- A valedictory session that summarized the technical presentations made during the conference.
- Three best paper awards, one in each of the three categories, viz. smart materials, actuators & control, and devices & systems (see p. 5).

## ISSS 2008 International Conference

G.K. Ananthasuresh

The ISSS International Conference on Smart Materials, Structures, and Systems was successfully held from July 24th to 26th, 2008, in the National Science Seminar Complex on the campus of the Indian Institute of Science (IISc), Bangalore. It was well attended by researchers from academia, government and private research labs, and industries in India and abroad. Dr. V.K. Aatre (former Scientific Adviser to the Raksha Manthri and currently a Visiting Professor in IISc), Professor P. Balaram (Director, IISc), Dr. G. Madhavan Nair (Chairman, Indian Space Research Organization-ISRO), Professor G.S. Dhande (Director, Indian Institute of Technology, Kanpur), and ISSS President Dr. A.R. Upadhyaya (Director, NAL) were present at the inaugural function.

Dr. P.S. Nair, the chair of the organising committee welcomed the guests and delegates and briefly described the conference programme. The traditional lamp-lighting took a smart twist in this conference wherein the guests had to press a remote button to light the lamp. Dr. A.R. Upadhyaya highlighted the ISSS activities, recalled the past conferences, and noted the increasing growth of ISSS in its size and activities. Professor P. Balaram, in his brief address to the audience, noted that IISc is committed to the success of its microsystems activities. Dr. Aatre reminded the audience the genesis of ISSS and noted the role ISSS has played in shaping the micro and smart systems research and development in India. He talked about the national programmes (NPSM, see Vol. 1, No. 1, p. 1 and NP-MaSS, see Vol. 2, No. 2, p. 1) that gave the necessary impetus for the initiation and growth of these areas in the nation. Dr. Madhavan Nair, in his address, highlighted the micro and smart systems activities of ISRO and noted that these technologies are valuable to the Indian space programme. Dr. G.S. Dhande, the inaugural speaker of the conference, gave a spirited talk on the role the micro and smart systems can play in helping the society. In particular, he noted how Indian Railways can benefit from these technologies. A vote of thanks was given by Dr. C.D. Sridhara (ISRO), the organising secretary of the conference. This was followed by the inauguration of the conference exhibition. Several companies and organizations that sponsored the conference had set up their stalls to display their capabilities. The past issues of Sukshma were displayed in the ISSS stall.

The technical part of the conference had an excellent start with the first plenary talk given by Professor Ajay Sood (Physics, IISc). Professor Sood gave an insightful lecture entitled "Nanotubes and Graphene as Smart Materials". The second and third days of the conference commenced with two plenary talks each. They were given by Prof. M. Eshashi of the Advanced Institute for Materials

Research, Tohoku University, Japan, and Professor Vijay Varadan of the University of Arkansas, Fayetteville, AR, USA, on the second day; Prof. Anurag Kumar of Electrical Communication Engineering, IISc and Prof. S. Mohan of Instrumentation Unit of IISc, on the third day. The topics covered by these eminent speakers highlighted the main theme of the conference and showed the way forward for advancing the research in the micro, smart, nano, and bio areas.

The technical programme of the conference was divided into parallel sessions held in three separate seminar halls and common sessions held in the main auditorium. The parallel sessions had oral presentations. These were divided into three categories, viz., smart materials and structures, microsystems, and modelling and control. There were 62 papers in these sessions. There were 24 additional invited talks in these sessions spread uniformly in all the sessions. The interactive poster session was a common session with 21 papers (see p. 4 for details). All the papers were selected through a full-paper peer review prior to the conference. This is a first for the triennial ISSS international conference. It would not have been possible without the help of the reviewers and authors who strived to achieve excellence in setting the quality standard for the conference.

In addition to the interactive poster session and plenary talks, there were two other common sessions. One was an informative session on India's micro foundries (see p. 5 for details) and a valedictory and awards session. The valedictory session was a special attraction at this conference wherein a succinct summary of the technical presentations was given by Dr. G.M. Kamath (NAL), Professor Kartik Venkataraman (Aero, IISc), and Professor K.J. Vinoy (ECE, IISc). Each of them covered the three themes of the parallel sessions and the interactive poster session. This session gave the audience an overall view of the conference and indirectly indicated the state of the art in micro and smart systems research in India. This was followed by the best paper awards ceremony (see p. 5 for the list of the award-winning papers).

The highlight of the conference was a student paper contest session. The six talks in this session were of the finest quality and were received well by the audience. These presentations made just before the valedictory session marked a fitting finale for the conference (see p. 7 for details).

The banquet dinner, sponsored by Bharath Electronics Limited, took place on the first day of the conference in Hotel Grand Ashok. The smooth running of the conference was a result of months of hard work, mainly by the ISAC/ISRO team headed by Dr. P.S. Nair. ISSS thanks this team for their excellent work.





Dr. A.R. Upadhyaya is the Director of National Aerospace Laboratories (NAL), Bangalore. He can be reached at [director@css.nal.res.in](mailto:director@css.nal.res.in).

I am happy to convey my greetings to all the members of ISSS at the closing of yet another eventful year (2007-08) for the Society. The ninth Annual General Meeting of the Society held on 5<sup>th</sup> of September 2008 at the National Aerospace Laboratories gave us an opportunity to report and reflect on our performance on many fronts as well as look at the future with reference to the goals of the Society.

The National Conference on Smart Structures and Systems, 4<sup>th</sup> in the series, held at Pilani in November 2007 (see Vol. 3, No. 2, p. 2) with the main theme of MEMS was a great success, thanks to the joint organizational efforts of Central Electronics Engineering Research Institute and Birla Institute of Technology & Science, Pilani. I am particularly happy that two distinguished scientists in the field and great contributors to the success of ISSS, Prof. A Selvarajan and Dr. Vikram Kumar were honoured on that occasion.

The efforts at human resources development, a must if we as a nation have to make any international impact in this area, have had a promising beginning with the training of a good number of teachers and students of Visveswaraya Technological University, Karnataka, and with the starting of a course on

micro and smart systems in the University from the next academic year. This is facilitated by the preparation of a text book and an experimental demonstration kit by some distinguished members of the society. This activity must broaden significantly and I am greatly enthused by the response from many educational institutions who have requested ISSS to conduct such courses in their institutions. In this regard, all of us must reflect on the observations made by our founder president, Dr. V. K. Aatre after his recent visits to China and South Korea that the total investment in India (both human resources and funding) in this area is abysmally low when compared to these Asian giants (see Vol. 3, No. 3, p. 3).

We have been planning an expansion of the Society by establishment of Chapters in other centres in the country where there is significant interest and activity. This has now been enabled by the formulation and adoption of the Chapter guidelines by the governing council. As you are aware, we already have Chapters at Hyderabad and Delhi, and we would welcome more such initiatives from the members. This would greatly help in expanding the base of the Society and spreading the activities in this critical technology area. I am very happy that the ISSS newsletter 'Sukshma' is doing its best to disseminate information both on the Society and on MEMS & Smart Structures activities in different institutions in the country. I thank the editorial committee for their committed efforts and wish them all the success. At the same time I request all the members to extend their full support to them by writing to them about their views, activities, and contributions.

It is a matter of great satisfaction that the fifth triennial ISSS International Conference on Smart Materials, Structures and Systems, conducted successfully on 24-26 July, 2008 at Bangalore again brought together scientists and engineers from India and abroad in greater numbers than before for presentation of their work and exchange of ideas. It is to be noted that Prof. S.G. Dhande, Director, IIT-Kanpur, in his inaugural address to the Conference highlighted the great potential for application of smart materials and MEMS in Indian railways. I believe that it contained an important message to all of us to look at opportunities and applications that are demanding and highly relevant but are sometimes overlooked. This year's conference also had a new feature; a special session of papers from young students which turned out to be a huge success judging by the response and commendation it received. I must thank ISRO and IISc for shouldering the responsibility of organizing this conference at our request and also the patrons and many organizations and individuals who supported us in this effort. The Organising Committee led by Dr. P.S. Nair of ISRO with members from ISRO, IISc, ADA, NAL, DRDO and many other organizations needs to be complimented for the meticulous planning, coordination and execution of all the organizational tasks which ensured a smooth conduct of the event. A detailed report on the Conference is separately published in this issue.

The new National Programme on Micro and Smart Systems (NP-MaSS) (see Vol. 3, No. 1, p. 1 and Vol. 3, No. 2, p. 1) piloted jointly by five concerned scientific departments of the government gives us an opportunity to consolidate the gains from the previous programme (NPSM) (see Vol. 1, No. 1, p. 1), and push towards application specific devices and systems. The programme's success would depend to a large extent on engaging the industries in defining potential devices and applications, providing design specifications, facilitating testing, and finally accepting of the finished product. NP-MaSS has also recognized the need and provided resources for HR development. I think ISSS can and should play a big role in supporting the programme in the above mentioned areas.

It is heartening to note that the ISSS family has grown with a good number of new additions during the year. We have also received good response to our request for institutional membership. In this regard, we greatly appreciate the initiative from our immediate past president, Prof. S. Mohan. I would like to conclude by thanking all my colleagues on the governing council for their initiatives and cooperation, and all the members and well-wishers for their support. Special thanks to Dr. V.K. Aatre, our founder president, for his continued active involvement and his suggestions and guidance in all our activities and programmes. I wish you all a professionally satisfying association with the Society in the coming year ('08-'09). Let us strive together to make it a vibrant institution with national relevance.

## Editorial Team

G.K. Ananthasuresh, IISc (Editor)  
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This newsletter is sent to all ISSS members by postal mail.

## ISSS Governing Council

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**Vice-president:** P.D. Mangalgiri  
**Secretaries:** S. Gopalakrishnan and K. Vijayaraju  
**Treasurer:** G.M. Kamath  
**Members:** G.K. Ananthasuresh, N. Bhat, S.N. Giri, J. Gurudutt, K.S. Hariprasad, S. Mohan, and the presidents of Hyderabad and Delhi chapters

To become an ISSS member, download:  
<http://www.issc.in/membership.html>  
and send the form with payment to:  
Institute of Smart Structures and Systems  
Department of Aerospace Engineering  
Indian Institute of Science, Bangalore  
560012, India

ISSS admission fee: Rs. 200  
Member:  
Rs. 200 (annual); Rs. 2,000 (life)  
Student member: Rs. 75 (annual)  
Corporate member:  
Rs. 10,000 (annual); Rs. 50,000 (life)  
Institutional member: Rs. 25,000 (life)  
Payable to "ISSS, Bangalore".



**SITAR** (Society for Integrated circuit Technology and Applied Research) is an autonomous government of India society that was founded with a mission to meet the microelectronic circuit requirements of various customers. SITAR has two fabrication facilities, one in Hyderabad and the other in Bangalore. The Hyderabad facility is manufacturing monolithic microwave integrated circuits (MMICs). The silicon fabrication facility is located in Bangalore and is in the business of ASICs and MEMS (see Vol. 3, No. 2, p. 3). Gallium Arsenide Enabling Technology Centre (GAETEC), located in Hyderabad is a vertically integrated facility having all the necessary capabilities such as design, fabrication, assembly, and testing under one roof.

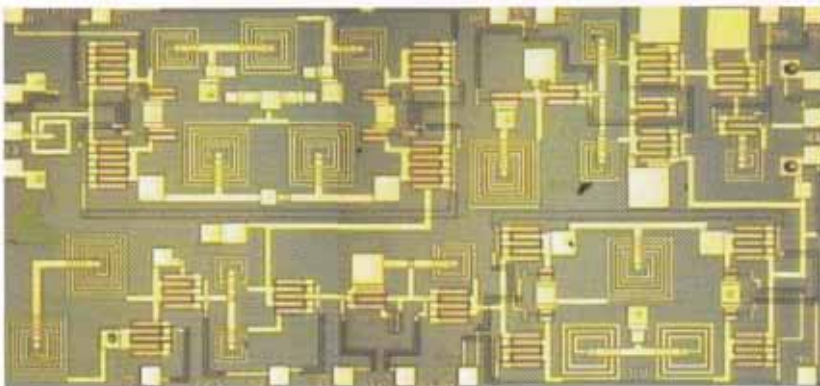
GAETEC uses the indigenous technologies developed by Solid-State Physics Laboratory (SSPL) for the production of MMICs. It has put into production 0.7 and 0.5 micron MESFET (metal epitaxial semiconductor field effect transistor) based technologies into production of a wide range of linear amplifiers and also a 0.7 micron switch technology necessary for production of SPDT (single pole double throw), SPST (single pole and single throw) switches, attenuators and phase shifters. The PHEMT (pseudomorphic high electron mobility transistor) technology for low-noise and high-power applications is ready for supplying prototype circuits.

The foundry has successfully designed, fabricated and supplied packaged parts such as amplifiers, switches, attenuators, phase shifters, and voltage controlled oscillators in various bands of frequencies to space and defence organizations. As a result, GAETEC is being

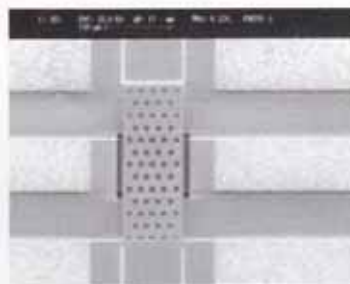
recognized as an organization that has many MMIC technologies with the capability to deliver parts with reproducible characteristics to its customers.

The RF MEMS switch technology is compatible with the GaAs MMIC Process Technology. So, it makes sense to develop GaAs based RF MEMS to be used for X-Band phase shifters. GAETEC has developed GaAs based RF MEMS switch technology using air bridge structures for eventual integration of these switches with GaAs MMICs.

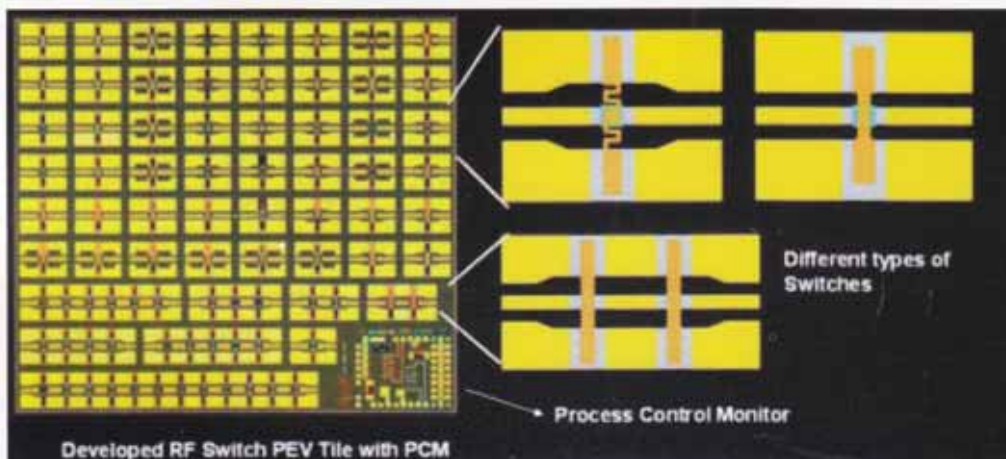
Dr. Muralidharan Rangarajan is the chief executive officer of GAETEC-SITAR. He can be reached at [ceo\\_gaetec@rediffmail.com](mailto:ceo_gaetec@rediffmail.com).



◀ A six-bit digital phase-shifter



◀ (left) A Guckel ring for process control monitoring  
(right) Top view of the perforated switch



◀ An array of RF switches along with process control monitoring (PCM) structures





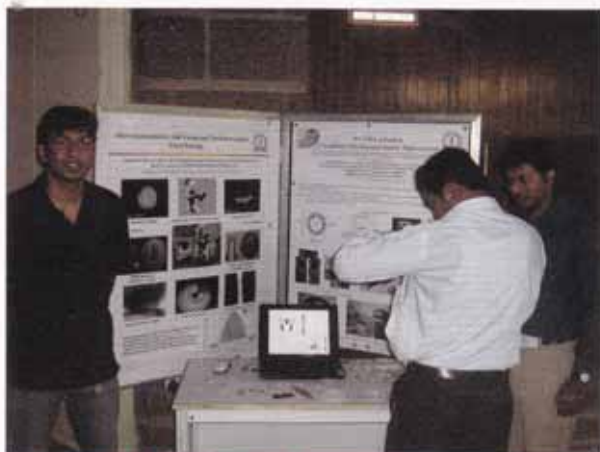
*Tradition. Technology. Mix it up. Smart lighting of the lamp in the inaugural ceremony.*



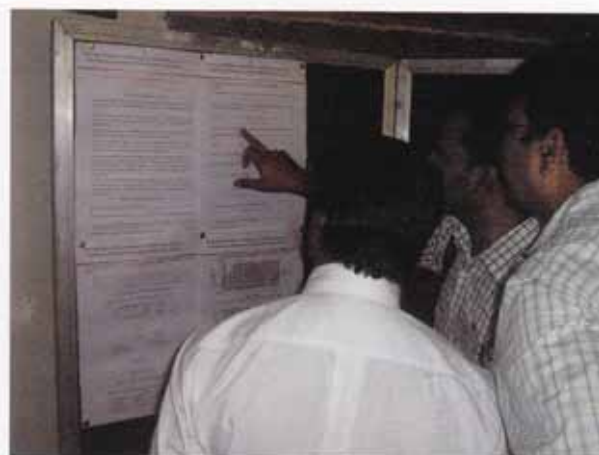
*A packed seminar hall, like this one, was the hallmark of most of the parallel sessions in the conference.*



*Exposure to all the interested attendees*



*Display of models and computer simulations*



*Opportunity to read between the lines to engender an extended discussion*



*Face-to-face interaction*



*Undivided attention of those who really want to know your work*



## Best of the best in the conference

### The best paper in smart materials category

"An Ultra-stable Cu Nanowire under Thermal-mechanical Loading: A Molecular Dynamic Study," by Vijay Kumar Sutrar (Mechanical Engineering Design Division, Aeronautical Development Establishment, DRDO, Bangalore) and D. Roy Mahapatra (Aerospace Engineering, IISc)

### The best paper in actuators and controls category

"Vibration Control of Pipes Conveying Pulsatile Fluid using Shape memory Alloy-based Actuators," by Nurul Huda Shaik and Bishakh Bhattacharya (Mechanical Engineering, IIT-Kanpur)

### The best paper in devices and systems category

"Experimental Studies on the Effect of Cryogenic Treatment on Residual Stresses and Dimensional Stability in Integral Diaphragm Pressure Transducers for Space Applications," by Geetha Sen, M.V.N. Prasad, M.M. Nayak (Liquid Propulsion Systems Centre, ISRO), Subhash Jacob, R. Karunanithi, and D.S. Nadig (Centre for Cryogenic Technology, IISc).

### The prize-winner in the student paper contest

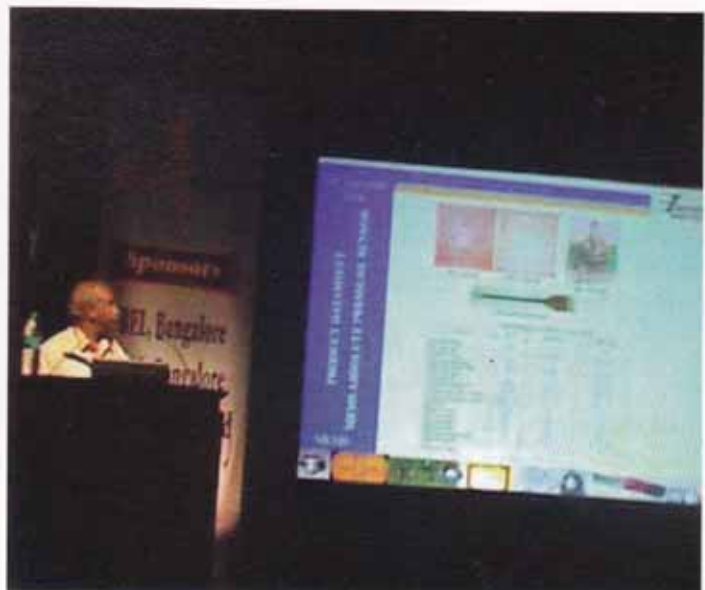
"Fabrication and Characterization of carbon Nanotube/Carbon Black/epoxy Thin-film Composites for Strain Sensing," by Sandeep Venkit Anand (Mechanical Engineering, R. V. College of Engineering, Bangalore) and Rejin Isaac (Mechanical Engineering, National Institute of Technology-Karnataka, Surathkal)



The conference was briefly interrupted when the unfortunate incident of serial bomb blasts occurred in Bangalore on the second day of the conference (July 25th, 2008) during the interactive poster session. The building was evacuated for a short period (see above). After ensuring the safety of the building, the conference resumed and the show went on.

## India's Micro Foundries - a special session at the conference

In a special session on the second day of the conference, three organizations that have helped researchers and industries fabricate their micro devices in India presented their capabilities and successes. These were BEL (see Vol. 3, No. 1, p. 3), CEERI (see Vol. 2, No. 3, p. 1), and SITAR (see Vol. 3, No. 2, p. 3).



Dr. K. Natarajan describing microfabrication capabilities of Bharath Electronics Limited, Bangalore.





The Institute of Smart Structures and Systems (ISSS) held a workshop on micro and nano Technologies at BMS College of Engineering, Basavangudi, Bangalore, from 28<sup>th</sup> of July to 2<sup>nd</sup> of August, 2008. BMS College of Engineering was the first private engineering college in India. The audience of the workshop consisted of a mixture of students and staff from diverse branches of engineering. Professors from the Indian Institute of Science (IISc) and the National Centre for Biological Sciences (NCBS) delivered lectures on a wide range of topics in nano and micro technologies. The purpose of the workshop was to expose the students and staff to MEMS and nanotechnology and to facilitate the opening of MEMS and nano laboratories in the BMS College of Engineering.

The workshop was initiated by a group of second-year students and staff at BMS College of Engineering who first contacted Dr. V.K. Aatre, currently a Visiting Professor in IISc and formerly the Scientific Adviser to the Raksha Manthri. The discussions resulted in a series of lectures given by the IISc faculty at BMS College of Engineering. A test was also held based on these lectures as a screening process to create a core group of students. The representatives of this core group and enthusiastic faculty members of the College pursued their goal of organizing a comprehensive workshop. Dr. Aatre discussed this matter with the administration of the college, who were very supportive. He then asked two project assistants in IISc to contact various faculty in IISc and NCBS to chart out a plan for the workshop. The project assistants, Kiran and Rakesh, prepared a schedule for the workshop under the guidance of Dr. Aatre and with the help of BMS College of Engineering.

The workshop was held over a period of six days with four lectures each day. The lectures covered the fundamentals of various aspects of MEMS and nanotechnology ranging from fabrication techniques to applications. The first two days dealt with MEMS and microtechnology. Some of the topics covered, in addition to an overview of microsystems, were thin-film deposition schemes and other microfabrication techniques, modeling of microsystems, inertial MEMS, RF MEMS and Bio-MEMS. The next four days concentrated on the nano scale and included topics such as nanomaterials, nano resonators, synthesis of nanostructures,

nanoelectronics, nanomechanics, organic nanoelectronic devices, genetic networks and insect flight. Since these are interdisciplinary engineering sciences that integrate many branches of engineering intimately, the course was useful and informative to every person in the audience and the topics covered allowed each student to choose an area that interested him or her. The lectures helped to understand not only its prospects but also the intricate involvement of different sciences in these technologies. Some of the topics were especially valuable to appreciate the application of basic electrical, electronic, mechanical and biological concepts in the design and functioning of MEMS structures and nano materials. Although it cannot be denied that it was somewhat challenging for students from one branch of engineering to grasp the concepts related to another, the lectures were prepared keeping this in mind and were successful in providing a broad idea of these concepts.

The workshop provided the students an overview of MEMS and Nanotechnology and has created a strong foundation for further learning. Several students have already identified their areas of interest and have formed micro groups which have begun to work on their ideas. The students involved in the Initiative are interested in trying their hand with cutting-edge technologies. They have planned several activities following the workshop such as lab and industrial visits so as to utilize the exposure it has provided in enhancing knowledge and experience. The management of BMS College is also opening MEMS and nano laboratories within the campus to further research in these areas. All this has happened because of an interest from a group of students which was subsequently supported by the faculty and the management of the College.

Lavanya Acharya, C.D. Rashmi, and K. Suhas are second-year students of the BMS College of Engineering. They can be reached at [lavanya.acharya@yahoo.co.in](mailto:lavanya.acharya@yahoo.co.in) and [suhas.asulikeit@gmail.com](mailto:suhas.asulikeit@gmail.com).

## ISSS News

**S. Gopalakrishnan**

The annual general meeting (AGM) of ISSS took place on September 5th, 2008, in NAL. It began with a welcome by Dr. Vijayaraju, joint secretary of ISSS. It was followed by a brief report on the activities of ISSS by Prof. S. Gopalakrishnan, joint secretary of ISSS. He informed the members about the ISSS-MEMS-2007 conference that took place in Pilani. This conference, jointly organized by CEERI and BITS, was inaugurated by Dr. T. Ramasami, Secretary, DST, and was attended by about 250 scientists from all over India. He also informed that Professor A. Selvarajan (retired professor, IISc) and Dr. Vikram Kumar (Director, NPL-Delhi) were honored for their distinguished services and outstanding contributions in the smart and micro technology areas.

It was noted that the governing council of ISSS has setup a committee headed by Dr. Mangalgi, vice president of ISSS, as chairman, Dr. R.V. Krishnan, former scientist, NAL, and Prof. S. Gopalakrishnan as members to draft the guidelines for the chapter operation. He informed that the drafted guidelines were approved

by the governing council and were circulated to members for information.

The secretary's report was followed by the treasurer's report by Dr. G.M. Kamath. He went through various expenditure and income status of ISSS and answered all the queries raised by the members. The members of the governing council were happy with the financial status of ISSS.

Dr. Mangalgi highlighted some clauses in the chapter guidelines. The guidelines deal with the election of office-bearers, financial powers, seeking and operation of donations, etc.

Dr. Upadhyya addressed the gathering and outlined his vision for ISSS in years to come. He also informed the members that ISSS has done a lot in propagating micro and smart technologies in the country and noted that it is an opportune time to pursue the nano area as well while continuing to promote the micro and smart systems areas. The meeting ended with a vote of thanks by Dr. K. Vijayaraju.



A special feature of the ISSS 2008 International Conference on smart materials, structures, and systems was the student paper contest. It started as a new experiment based upon a suggestion made by Dr. V.K. Aatre. Full papers were solicited from undergraduate students prior to the conference. It was stipulated that only undergraduates be authors on these papers with a view to ensure that all the work reported is carried out by the students themselves. An announcement was sent out to various colleges, universities, and research institutions by e-mail and post. It was also posted on the conference web site. Despite the short notice, papers came in. Six papers that are seen in the box below were short-listed. The authors of these papers were invited to present their work in an exclusive oral presentation session.

Three judges from IISc and ISRO were present in the student paper contest session. The judges had the opportunity to read the full papers before the conference. They were given a scoring sheet to assess the papers and the presentations. The students were informed of the evaluation criteria well in advance. The seminar hall was full; there was no room left even for standing. The students made impeccable presentations that elicited applause and commendation from the audience. The quality of work of all the papers was so high that many felt that this was one of the highlights of the conference and some said that this was the best session of the conference.

It was the judges who had the difficult task of choosing one for the best student paper award. The award aside, all the students were honored by the enthusiasm with which this session was received and the compliments showered on them. This being the last technical session, the conference ended on a happy note that the future of the field is in good hands of these and other budding researchers.



A contestant, Naveen Shamsudhin (NIT-Trichy), presenting in the student paper contest session.

**K. Suhas, BMS College of Engineering, Bangalore, Karnataka**

FM technique for sensing low pressures using a MEMS capacitor

**Naveen Shamsudhin and Ramamoorthy Luxman, NIT-Trichy, Tamilnadu**

Water quality monitoring instrument to measure pH, chlorine and turbidity using RGB color sensor

**Savita Maurya, Banasthali University, Banasthali, Rajasthan**

Microstrip high performance switch: design and simulations

**Sandeep Venkit Anand and Rejin Isaac, RV College of Engineering, Bangalore, and NIT-Surathkal, Karnataka**

Fabrication and characterisation of carbon nanotube/carbon black/epoxy thick film composites for strain sensing

**M.S. Vinod and Alok Shankar, RV College of Engineering, Bangalore, Karnataka**

Dispersion of nano-materials into structural adhesive: electrical and mechanical properties

**Uday Bhaskar Katreddi, IIT-Madras, Chennai, Tamilnadu**

A novel polysilicon based process for three terminal micromachined cantilever and measurement of in-use stiction

## Conference announcements

IUTAM Symposium on Multi-functional Materials, Structures, and Systems, 10-13 December, 2008, Satish Dhawan Auditorium, IISc, Bangalore.


International Conference on MEMS 2009, 3-5 January, 2009, IIT-Madras, <http://www.icmems2009.iitm.ac.in/>

International Conference on Active/Smart Materials" (ICASM) during January 7-9, 2009, Thiagarajar College of Engineering, Madurai, <http://www.tce.edu/icasm/>

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