

INDIAN INSTITUTE OF TECHNOLOGY KANPUR  
Samtel Centre for Display Technologies



Internal Review Meeting  
PBCEC, IIT Kanpur

April 26, 2008

## People behind the Vision



**Mr. Satish Kaura**, Chairman and MD of *Samtel Group of Industries*, the first awardee of *Distinguished Alumnus Award* of IITK. He has been the principal motivator, resource provider and conceptualizer in establishing the center. He is the co-chairman of the National Advisory Committee of the Centre.



**Prof. Sanjay Govind Dhande**, Director *I.I.T. Kanpur*. Professor Dhande played a crucial role in planning and conceptualizing the centre as the then Dean, R&D of IITK. He is the Chairman of National Advisory Committee of the Center. He provides both academic and organizational leadership to this unique experiment.



**Prof. K. R. Sarma**, currently Technology Advisor to *Samtel Group of Industries*, and one of the most revered former faculty members who helped shape I.I.T. Kanpur in its founding years. With his experience in academia and industry, intimate knowledge of people and institutions, he continues to be the most important link in this experiment.



**Prof R. Sharan**, (former Professor of Electrical Engineering at I.I.T. Kanpur), with his vast experience of working with people, and a variety of disciplines was instrumental in putting together a large committed interdisciplinary group at IIT Kanpur and led the Centre in its formative stages. He continues to guide the activities.

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## **Samtel Centre for Display Technology** **Objectives of the Centre**

- To conduct basic research in science and technology relevant to the field of electronic displays.
- To undertake Human Resource Development in display technology,
- To organize continuing education programmes in areas related to display technology,
- To organize other professional activities such as Conferences, Workshops, and Short Courses in display technology,
- To establish a tripartite relationship between industry, academia and various governmental agencies to nurture and support the growth of science and technology in the field of electronic displays with the aim of making India a global leader in Display Technology.

### **VISION:**

**Bringing academia and industry together to invent and innovate display technologies and underlying science**

### **MISSION:**

To conduct R&D so as to nurture and support growth of science and technology of electronic displays;

To establish a tripartite relationship between industry, academia and governmental agencies so that the country can become a global leader in Display Technology;

To develop Human Resources in Display Technology.

### **THE GUIDING PRINCIPLES IN ACTION AT SCDT:**

The processes involving collaborative R&D are common to all of the objectives of the Centre. SCDT is certainly seen to have achieved these objectives with some measure of success. It may be appropriate to highlight that among many other things the three strongest reasons of success are the following:

- SCDT has been able to motivate a band of faculty members to change their field of activity to the broad areas of future technology in line with the objectives of the Centre. This brought a sense of belonging and commitment essential to success in any collaborative project.
- The faculty's belief that interaction with industry would bring problems challenging to real-life technology into their text and provide a useful context to innovation.
- The belief that support to R&D from industry would catalyze research funding.

*All the projects undertaken at SCDT are geared towards developing "links" in the "Chain of Links" needed for technology development.*

## Samtel Centre for Display Technologies Governance

| <b>National Advisory Committee</b>   |
|--|
| <b>Prof. S.G.Dhande (Chair)</b><br>Director, IIT Kanpur                            |
| <b>Shri Satish K. Kaura (Co-chair)</b><br>CMD, Samtel Group of Industries          |
| <b>Dr. V.Rao Aiyagiri</b><br>Head SERC & Advisor, DST, New Delhi                   |
| <b>Dr. Dipankar Banerjee</b><br>Chief Controller (R&D), DRDO                       |
| <b>Dr. Harinarayana Kota</b><br>Raja Ramanna Fellow, NAL, Bangalore                |
| <b>Prof. K. Muralidhar</b><br>Dean R &D, IIT Kanpur                                |
| <b>Prof. K.R.Sarma</b><br>Adviser Technology, Samtel Group of Industries           |
| <b>Dr. M.J.Zarabi</b><br>Former CMD, SCL, Chandigarh                               |
| <b>Shri Rajesh Kakkar</b><br>Vice president ( Strategy) Samtel Group of Industries |
| <b>Prof. Satyendra Kumar</b><br>Coordinator, SCDT, IIT Kanpur                      |

| <b>Centre Consultative Committee</b>  |
|---|
| <b>Prof. S.G.Dhande (Chair)</b><br>Director, IIT Kanpur   |
| <b>Prof. K. Muralidhar</b><br>Dean R &D, IIT Kanpur   |
| <b>Prof. K.R.Sarma</b><br>Adviser Technology,<br>Samtel Group of Industries   |
| <b>Prof P.K. Kalra</b><br>Head, Electrical Engineering  |
| <b>Prof Rajiv Shekhar</b><br>Head, Materials & Metallurgical Engineering  |
| <b>Y.N. Mohapatra</b><br><b>Deepak Gupta</b><br><b>Monica Katiyar</b><br><b>S.S.K. Iyer</b><br><b>S Panda</b><br><b>A. Garg</b> |
| <b>Satyendra Kumar</b><br>Coordinator, SCDT, IIT Kanpur   |

### **National Advisory Committee**

A National Advisory Committee (NAC) shall provide general directions, and specify the annual program of activities, and review the progress of various on-going programs. The NAC, with Director IIT Kanpur as its Chairman, and MD of Samtel Group of Industries as the Co-chairman, shall consist of the Dean R&D, IIT Kanpur, and Head, Corporate R&D of Samtel Industries or a nominee of CMD, Samtel, along with three others nominated by the Director from Government scientific and technological organizations and agencies (such as DST, MCIT, DRDO, CSIR etc.) and industries supporting and actively promoting industry-academia interactions. The Coordinator of SCDT at any time is a permanent member of the NAC and acts as its member secretary.

### **Centre Consultative Committee**

The operational management of SCDT is administered by a Centre Consultative Committee, with Director IIT Kanpur, as its Chairman, in order to monitor functioning of the Centre and advise plan of action. The Centre Consultative Committee meets at the least twice in a year or more as may be required. The Dean R&D, and at least two Head of Departments of IIT Kanpur, two members of the core group of faculty, and Coordinator, SCDT are its members. The Coordinator, SCDT acts as member secretary for the Centre Consultative Committee. The other members of the centre consultative Committee shall be appointed by Director IITK in consultation with Coordinator, SCDT.

### **Samtel Project Review Committee**

There shall also be a Samtel Project Review Committee (SPRC) to review any projects sponsored, or being carried out in collaboration with Samtel in SCDT, and to consider new projects proposed by various Faculty members of IITK of interest to Samtel. The Samtel Project Review Committee shall be headed by the Chairman and Managing Director of Samtel or his nominee and shall have another five representatives. The constitution of the Project Review Committee shall be three members from Samtel and three members from IITK of which the Dean R&D of IITK will be a permanent member.

## Samtel Centre for Display Technology Personnel

### Core Faculty

| SI No | Name                | Department |
|-------|---------------------|------------|
| 1     | Dr. Satyendra Kumar | Physics    |
| 2     | Dr. Y. N. Mohapatra | Physics    |
| 3     | Dr. Baquer Mazhari  | EE         |
| 4     | Dr. Deepak Gupta    | M.M.E      |
| 5     | Dr. Monica Katiyar  | M.M.E      |
| 6     | Dr. S.S.K.Iyer      | EE         |
| 7     | Dr. Sidhartha Panda | ChE        |
| 8     | Dr. Ashish Garg     | MME        |
| 9     | Dr. Vibha Tripathi  | EE         |

#### **Associated Faculty:**

Several faculty members from various departments, besides the core faculty members, contribute to the ongoing research activities of the centre as well as short term projects sponsored by industry (Samtel) from time to time.

#### **Current Personnel:**

**Research Scholars (Ph.D) - 19**

**M.Tech Students – 22**

**B.Tech/ M.Sc. – 15**

**Project Scientists/Engineers - 4**

**PDU Personnel (Samtel Engineers) - 7**

**Technical & Office Personnel (Projects) – 5**

Apart from the faculty members of the Institute, the activities of the Centre are mainly carried out by graduate and undergraduate students, project technical and engineering personnel. In order to operate effectively a small number of office personnel are also required. A team of seven visiting Samtel R&D Engineers form the team for implementation of the PDU.

The areas of activity of the Centre are emerging disciplines, and as a result we do lose trained project employees regularly to Europe and now increasingly to the Far East. This remains an area of concern for sustained technology development.

## **Current Activities of the Centre**

### **Executive Summary**

The main aim of this research center is to work on several aspects relevant to electronic display engineering. It was realized quite early that a multidisciplinary research group has to be set up if these activities are to succeed. Consequently, a group of faculty members drawn from several departments have joined together to carry out this research. The Centre has a National Advisory Committee. A separate new building with the state-of-the-art facilities has been created from funds shared by IIT Kanpur and Samtel Group (<http://www.iitk.ac.in/scdt/>). The Centre has established itself organizationally as a fully stream-lined Centre of research within IIT Kanpur, acting as inter-disciplinary hub of display related R&D with direct impact on industrially relevant technologies. The principal objectives of the Centre are to conduct R&D so as to nurture and support growth of science and technology of electronic displays, to establish a tripartite relationship between industry, academia and governmental agencies to enable the country become a global leader in Display Technologies.

The first phase of the research was initiated with a flagship OLED<sup>1</sup> project funded by Samtel and DST. This has been a remarkable one – a phase in which faculty members from several departments joined hands and shared resources to work on all aspects of a functional device: from molecules to materials, materials to thin films, and thin films to devices. While the work was going on in the laboratories, a new idea of focused industry-academia interaction was taking a definite shape that has now established itself as a model in the S&T environment of the country. Before the first project was over, DST and Samtel Industries reposed their faith in the Center and funded it to establish a ‘Prototype Development Unit (PDU)’ with a very specific goal of developing small screen OLED based display. As a unique feature, the PDU team consisting of engineers from Samtel was led by a faculty member from IIT Kanpur.

Now as we all know, the PDU has completed more than two years of its functioning and has already demonstrated a full color small display (1” diagonal, 96x64 resolution). The level of planning, discussions and execution that has gone into the “PDU Experiment” has been educative for all of us at the Centre.

Through this process, the SCDT has gained the core competence and has set-up the world class research facilities in the emerging area of Organic Semiconductors. Consequently, the number of students associated with the Center has increased and as a natural consequence the activities have diversified into Organic Solar Cells, Thin Film Transistors (TFT) and Sensors.

SCDT faculty actively participated in the development of plasma display panels (PDP) at the Technology Lab in Ghaziabad and carried out focused research and development activities towards crucial dielectric materials for PDP at IIT Kanpur. The funding was provided by Samtel and Ministry of Communication and Information Technology (MCIT). Once again, the efforts have led to a bigger project on technology development for High Definition Plasma Display Panels involving Samtel, IIT Kanpur, Allahabad University, NPL Delhi and CGCRI. This time the funding is provided by the CSIR under the New Millennium Initiative.

In the last two years, SCDT also played a pivotal role in increasing the awareness and interest in the display technology in the country through its leadership in the Society for Information Display (SID) activities. SCDT organized a major SID symposium in New Delhi. The Brainstorming meeting on TFT at SCDT in September 2005 was followed up by formulation and presentation of a proposal on “The National TFT Initiative” to the cross-disciplinary technology group of Steering Committee on Science and Technology for the 11<sup>th</sup> Five-Year Plan. Proposal has been included for funding by the Planning Commission.

There are 9 faculty members in the SCDT Core group and the number of Ph.D. students has increased to 19. Today, the total number of participants in the SCDT activities

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<sup>1</sup> OLED – Organic Light Emitting Diodes

stands at 85. ***As we expand the research activities, the need for laboratory and office space becomes more acute. The retention of trained manpower and keeping their motivation level high requires innovative solutions.***

#### **MAJOR ACTIVITIES OF THE CENTRE: ON-GOING PROJECTS:**

There are several projects that explore the basic science and develop major technology platforms relevant to the current and future needs of display industry. Projects are funded through DST, MCIT and CSIR. Founder partner, Samtel Industries, remains the major sponsor of projects sharing cost with the government agencies.

The SCDT acts a nucleation centre and core of research activities for the participating faculty. The key processing and characterization facilities are housed in the Samtel Research and Development Building, faculty members continue to pursue the research in their parents departments. With the development of basic infrastructure and facilities in the area of Organic Semiconductors and Display Technologies through the first OLED project, the SCDT faculty started attracting funding from various agencies. A list of projects undertaken by the SCDT faculty is given below and is followed by a brief summary of various research themes.

#### ***Projects Undertaken by SCDT Faculty***

| <b>Sl No.</b> | <b>Project Name</b>  | <b>Funding Agency</b>             | <b>Amount (Rs. in Lakhs)</b> | <b>Duration</b>  |
|---------------|--|-----------------------------------|------------------------------|------------------|
| 01            | Research and Development in the Technology of Active Matrix Organic Light Emitting Diode Displays  | <b>DST &amp; Samtel</b>           | <b>300.00</b>                | <b>2002-2005</b> |
| 02            | Molecular Electronics: Fabrication of new photolithography-less vertical organic thin film transistors (OTFTs)   | <b>MCIT</b>                       | <b>37.58</b>                 | <b>2004-2007</b> |
| 03            | UV and Near-UV Light Emitting Diodes using Polysilanes   | <b>DST</b>                        | <b>24.00</b>                 | <b>2004-2007</b> |
| 04            | Development of Prototype Full Color Organic Light Emitting Diodes (OLED) Display   | <b>DST &amp; Samtel</b>           | <b>1575.00</b>               | <b>2005-2008</b> |
| 05            | Development of Magnesium Oxide Coatings by Sputtering for Plasma Display Panels  | <b>MCIT &amp; Samtel</b>          | <b>174.00</b>                | <b>2005-2008</b> |
| 06            | Fabrication of efficient thin-film organic solar cells based organic/inorganic heterojunction  | <b>MHRD</b>                       | <b>17.50</b>                 | <b>2005-2008</b> |
| 07            | Low Cost and Flexible Solar Cells for Developing Countries   | <b>Swiss NSF</b>                  | <b>101.00</b>                | <b>2005-2008</b> |
| 08            | Fabrication of efficient thin-film organic solar cells based organic/inorganic heterojunction (2005-2008)  | <b>DST</b>                        | <b>15.00</b>                 | <b>2005-2008</b> |
| 09            | Printable Electronics Development ( <i>Centre for Nanotechnology at IIT Kanpur</i> )   | <b>DST</b>                        | <b>1180.00</b>               | <b>2006-2011</b> |
| 10            | Development of Next Generation Plasma Display Technology and a 50 inch HDPDP Prototype (Total Project cost Rs. 2430.50 includes Samtel, IIT Kanpur, Allahabad University, CGCRI Kolkata and NPL New Delhi) | <b>CSIR (NMITLI) &amp; Samtel</b> | <b>132.00</b>                | <b>2007-2010</b> |
| 11            | Samtel Centre for Display Technologies   | <b>Samtel Color Ltd</b>           | <b>Rs. 22.50 (Annual)</b>    | <b>1999-</b>     |



# Significant Achievements:

## A brief summary of projects:

### 1) PLED/OLED Development

Looking at the international scenario of developing flat panel technologies today, the Centre decided to take up Development of 'Organic Light Emitting Diodes (OLED)' as its first major project (2002-2005) costing more than Rupees three Crores funded equally by DST and Samtel Industries. Successful completion of the project has led to the setting of a Prototype Development Unit (PDU) for passive matrix displays suitable for mobile phones.

Many of the polymers and small molecules used for device fabrication are being synthesized at the centre. The Centre has developed all unit processes required for fabricating a variety of OLED structures for purposes of optimization and model validation. The performance standards in terms of brightness and threshold voltage are comparable to International standards.

A new family of polymers based on Arylenevinylenes-co-pyrrolenevinylenes derived from divinylaryl bridged bispyrroles for electroluminescent and organic applications. To take advantage of the designer properties several strategies for blending with polycarbazole has also been developed and tested with fabrication of devices. The group has traced transformations from molecules (bispyrroles) to oligomers, and thin films to devices to reveal the comparative logic of inclusion of bridging groups, and hence their role in tailoring the optoelectronic properties of materials derived from bispyrroles.

### 2) Development of MgO and novel dielectric coatings for Flat Panel Plasma Displays:

Thin films of magnesium oxide play a crucial role in the development of plasma display panels (PDP). A project costing about Rs. 1.8 Crore has been sponsored by Ministry of Communication and Information Technology for joint development at IIT and Samtel Industries. Another project has been sponsored under the New Millennium Initiative of the CSIR to develop next generation High Definition Plasma Display Panels. SCDT is spearheading the development of high secondary electron emission dielectric materials for the project (Rs. 1.32 Crore). SCDT has developed magnetron sputtering process for the deposition of MgO films. A secondary electron emission measurement system has been developed to characterize the dielectric coatings under environment similar to the PDPs.

### 3) Printable Electronics (*Nano Technology Centre*):

The NSTI funded interdisciplinary proposal to setup a "Centre for Nanotechnology" at IIT Kanpur was formulated to carry out, in its first phase, technology development in the following three inter-related areas:

- (i) Development of Printable Organic Electronics with Organic-RFID tags as the first demonstrator prototype,
- (ii) Nano and meso-scale patterning based technologies of polymers with applications in fluidics, sensors and manufacturing of programmable structures, and
- (iii) Development of a versatile focused ion beam tool based on microwave plasma ion beam for applications in patterning and templating of soft-materials and substrates.

The Project has been initiated in January 2007 to a current outlay of 11.5 Crores for a period of 5-years.

### 4) Simulation & Display Electronics:

Organic light emitting diode based displays can be fabricated either as passive matrix panels consisting of only OLEDs or Active matrix panels in which the OLED is integrated with thin film transistors (TFT) in a suitable manner. An analysis of problems in passive matrix displays has been carried out including dynamic response time and crosstalk, and modified pixel circuits for improved performance proposed along with design rules.

### **5) Organic Solar Cells:**

Optimization of materials and structures for efficient solar cells has been started. Solar cells based on small molecules (CuPC, C60 etc) as well as polymers (P3HT, PCBM etc) are being developed. Swiss National Science Foundation has sponsored a project on flexible solar cells in collaboration with ETH Zurich (Swiss Fr 370,000). Another project on the fabrication of thin film organic solar cells has been sponsored by the DST under Young Scientists Scheme (Rs. 15 lakhs).

### **6) OTFT, UV Emitters & Sensors:**

In addition to OLEDs, the centre is also involved in major advancements in the area of organic photoelectronics as a whole with focus on organic thin film transistors (OTFT), UV emitters and sensors. Thin film transistors based on pentacene and P3OT have been developed. The channel current measured in these devices is very encouraging and demonstrate their potential use in organic electronic circuits. Polysilane based UV emitters have been developed. This work has led to a patent on UV and white light OLEDs. Significant understanding of principles of molecular design which may help UV degradation resistant has been carried out leading to a Ph.D. thesis.

Polymer-based chemical sensors is a new area taken up by the Center. Studies are being initiated on microfluidic chemical sensors, where microchannels in the polymer serve as microreactors, and OTFTs would be used to transduce the specific chemical reactions to quantifiable electrical readouts. Studies, such as those on surface modifications, surface characterizations, microflows, would be used to optimize the device performance.

### **7) Prototype Development: A Unique Experiment**

The Centre has begun a unique experiment of locating a knowledge-intensive prototype development unit (PDU) within the Centre with industry participation. The development of a prototype for small size display based on OLED has been initiated jointly with Samtel and Department of Science & Technology (DST). The PDU team dedicated to fabrication and development of full-color (RGB) organic light emitting diode (OLED) displays specifically for mobile applications. PDU consists of 6 dedicated members - 5 Research Engineers appointed by Samtel and 1 project employee. Graduate students and faculty from SCDT also participate in various research activities and discussions with the PDU members.

Since its inception in May 2006 the PDU have taken healthy strides in coming up with a working prototype within the set deadline. So the team has successfully fabricated the three basic colors – Red, Green and Blue in large pixels. Device efficiency of 14 cd/A (Green), 7 cd/A (Blue) and 3cd/A (Red) with brightness of more than 10,000 cd/m<sup>2</sup> have been achieved so far. These numbers are very close to the industrial standards. The Doosan cluster tool for fabrication of OLEDs was installed in mid-2006 and devices are now regularly fabricated. The automation for device characterization has been done. Ancillary units like device encapsulation system, lifetime measurement setup are also in place. A full color small display with image transfer has been demonstrated.

## **SCDT Facilities**

### **Clean Room**

The Centre has set-up a 220 square meters of ISO 6 (class 1000) clean room space with the cleaning and entry protocols comparable to industry standards. This is a unique facility in the country where even under-graduate students get access to the clean room facilities equipped with the best device processing and characterization facilities. The facilities include: Integrated Glove Box Vacuum Deposition for polymer based devices and, Ultra High Vacuum R & D OLED System for small molecule devices, ITO Deposition, Oxygen Plasma Treatment of ITO, Spin coating, Vacuum Drying and UV-Ozone Treatment. A yellow room with mask aligner and photolithographic facilities is also established through a DST-Samtel funded project on prototype development.

### **PROCESSING FACILITIES**

1. Integrated Glove Box Workstation:
2. UHV Organic Evaporation System:
3. Cluster Tool for OLED based Display Prototype Development
4. Vacuum Drying / Thermal Conversion Unit :
5. Oxygen Plasma Treatment for Substrates :
6. Pulsed DC Planar Magnetron Sputtering Unit for MgO Deposition
7. RF Planar Magnetron Sputtering Unit for ITO and Metal Deposition
8. 18 Megaohm Water facility

### **DIAGNOSTIC FACILITIES**

1. Thickness Profilometer and Imaging (Tencor Alphastep 500)
2. Optical Imaging system using CCD (LEICA)
3. Mini Prober (Wentworth)
4. Electrical Measurements workstation (Keithley)
5. Spectroradiometer (MINOLTA)
6. Sub-nanosecond Time Resolved Photoluminescence (TRPL) system (IBH)
7. Spectroscopic Ellipsometer (JY Horiba)
8. Standard Photoluminescence
9. An integrating sphere (Labsphere) based PL quantum efficiency measurement system
10. Facilities for charge transient, electroluminescence transient, surface photovoltage, and photocurrent measurement for monitoring charge processes in devices
11. Kelvin Probe for workfunction measurement
12. Thermo Gravimetry/Differential Thermal Analyzer –(Model TG/DTA 6300)
13. Electro-absorption measurement system
14. Secondary electron emission Coefficient ( $\gamma$ ) Measurement tool (SEE)
15. UV/VIS/NIR Spectrophotometer (Perkin Elmer (Lambda 750))
16. Solar Cell Spectral Response Measuring Unit-External Quantum Efficiency unit
17. Mask Aligner Süss Microtec, Germany Mask Aligner (Model MA 1006)
18. Scanning Electron Microscope (FEI, Inspect S)
19. Cathodoluminescence Spectrometer (EOS, Canada) fitted on SEM (TESCAN, Vega LSU)

# SCDT OUTREACH

## HRD activities at of the centre include

- Summer course on “Organic Electronics and Displays” are organized annually.
- The summer course the “Organic Electronics 07” attracted 17 Korean students from two different Universities in Korea – Hoseo and Dankook.
- M.Tech. and Ph.D. projects on Science and Technologies of Displays. So far, 8 PhD and 43 M.Tech theses have been submitted by the students working with SCDT.

## Conferences & Workshops:

- **Indo-Italian Workshop on Organic Semiconductors (IIWOS) 2003:** was held between 14-17 October, 2003. More than 10 Italian scientists from eight institutions, 75 participants from India including 40 from outside Kanpur participated in the workshop. There were 18 presentations and 13 posters covering a whole range of basic and applied research on organic semiconductors.
- **A day-long In-house workshop on “TFT Technologies”** was held on 10 May 2005. This was attended by over 65 students and faculty. Dr. Phadke and Dr. Sai from MCIT, New Delhi were among the invitees. This meeting was used as a preparative meeting in our run up to the “Discussion Meeting on TFT Technologies” being held on 23 September at IIT Kanpur. The intention has been to chart out a possible roadmap for the development of TFT technologies which is indispensable for any large area electronic applications.
- **‘Organic Electronics & Flat Panel Displays’** was held between July 11-15, 2005. This was attended by over 25 students chosen from a variety of top institutions in the country. The course is fully videotaped, and is being offered as training material for engineers joining us on our projects including those in the PDU
- **Discussion Meeting on Thin Film Transistor (TFT) Technologies** was held on 23 September 2005. Dr. R. Chidambaram, Principal Scientific Advisor to Govt. of India was chair of this meeting
- **The facilities at PDU dedicated to the Nation held was 5 June 2006:** inauguration by Shri Kapil Sibal, Union Minister of Science & Technology and Ocean Development on 5th June, 2006.
- **A QIP Short course on ‘Organic Electronics’** was held between July 17-21, 2006: was attended by over 20 faculty chosen from a variety of top institutions in the country.
- The Centre along with the SID India Chapter organized the **9<sup>th</sup> Asian Symposium on Information Displays ASID’06 , from October 8-12, 2006 at India Habitat Centre, New Delhi.** Over 380 participants including about 120 from abroad attended the Symposium. This was first such event on the Science and Technology of Displays that was organized in India. Major industries such as Samtel, Videocon, Marvell and Intel actively participated and sponsored the event.

### **Society for Information Display: SID India Chapter**

The SID *India Chapter* is housed in SCDT and the faculty has taken an active leadership role in the SID activities in India. The SID membership has grown more than three folds. The SID has provided an excellent platform for networking with the most active workers in the academia and industry across the globe.

## **PATENTS, PUBLICATIONS, & Awards**

SCDT faculty and students have published more than 50 papers in refereed Journals and have presented their work in several national and international conferences. Ten patents have been filed so far. SCDT faculty and students have won several recognitions for the work carried out at the Centre.

## **NETWORKING, LECTURES & CONFERENCES:**

The work being carried out by the Centre has been presented regularly in many international and national fora. The Centre has encouraged and supported financially for visits of students and faculty abroad to present their work. Some of the notable Conferences attended in the last two year are listed below:

- Society for Information Display SID Symposium in San Francisco, USA, May 2006.
- European Materials Research Society (E-MRS), Nice, France, June 2006
- Society for Information Display SID Symposium in Long Beach, USA, May 2007.
- OLEDs Asia 2007, Taipei , Taiwan ROC, April2007
- European Materials Research Society (E-MRS), Strasbourg, France, June 2007
- 10<sup>th</sup> Asian Symposium on Information Displays, Singapore, August 2007

Our network of contacts both in the Industry and academic circles has increased many folds. In fact now we as group are known to almost all international groups, equipment and materials companies, and in general in the OLED community. This has been made possible by the visits of the faculty members abroad in connection with the activities of the Centre.

Our regular lecture series held every Tuesday attracts nearly 40 students and faculty, and speakers have been drawn from other Departments and institutions. In relevant national Conferences of repute as in Photonics, and International Workshop on Physics of Solid State Devices (IWPSD), we have been able to have symposia purely devoted to Organic Displays and Devices. These activities have established our leadership role in the area in the country.

**Present Financial Profile:**

Annual Grant (Samtel – IITK MOU) - Rs. 22.5 Lakh  
Annual Grant (IITK) - Rs. 6.00 Lakh  
+ Sponsored Projects

In addition to the sponsored projects (page7), the Centre carries out its activities through an annual grant of Rupees 22.5 lakhs under the provisions of MOU with Samtel Industries. This level of support has now been assured till 2010 under the MOU signed recently. This financial support is critical for the overall activities of the Centre and its budgeting for the current financial year is proposed in a separate item. The principal use of these funds is to retain good quality scientific and technical personnel at the Centre contributing towards general objectives of the Centre and facilitation of on-going projects. Incentives for travel, organization of courses, meetings and brainstorming sessions, and initial phase support for new ideas and projects are also borne from the same funds.

In addition, the Institute has been generous to us in difficult times. It has provided funds for infra-structure, and now contributes Rs. 6 lakhs annually (Rs 4 lakhs for non-consumable and Rs 2 lakhs for consumables).

## Future Course of Action:

The SCDT group is keeping itself fully aware of the new developments as reflected in the list of sponsored projects undertaken by the faculty. In particular, in view of the knowledge base developed in the group and the research infra-structure that has been created, faculty proposes to continue to work in the following areas:

- ◆ Organic Light Emitting Diodes based Display Devices
- ◆ Materials and structures development for Plasma Display Panels
- ◆ TFTs (organic AND silicon based) towards integration in OLED displays
- ◆ Printable electronics
- ◆ Sensors

The following area will be strengthened and explored in the coming years:

- ◆ **Novel OLED structures:** Doping of organic semiconductors will be explored towards fabrication of pin OLED structures.
- ◆ **White OLED:** So far the group has concentrated on the materials and device structure for RGB OLED devices. Development of white OLEDs would be undertaken as these provide an ease of manufacturability for full color OLED based displays using colored filters. Moreover, the increase in luminous efficiency and lifetimes would lead to lighting applications.
- ◆ **TFTs :** Active matrix addressing is necessary to develop marketable organic displays in future. The technology development for thin film transistors is necessary. The work on organic TFT would continue at the research level, TFT research also may be taken to the level of prototype development. Further, exploratory work on oxide based transparent TFTs has been started at the exploratory level.
- ◆ **AMOLED Display Development :** Next phase of PDU is planned with the development of amorphous silicon based TFTs for integration with the OLEDs for a full color active matrix OLED display.
- ◆ **Sensors :** The work on organic sensors– bio-diagnostics and chemical will grow
- ◆ **Solar Cells:** The results on Organic Solar Cells are highly encouraging and the activity will be enhanced to develop solar panels. In particular, the activities on Solar Cells will be established in four major themes:
  1. Solar Cell basic device research (*Organic and Nano- Semiconductors*)
  2. Solar Cell R&D at prototype level (*Silicon thin films*)
  3. Integration of Solar Cells with end-use devices (*Innovative Applications*)
  4. Demonstration projects with research on life-time testing and utility integration (*Swimming Pool with solar thermal water heating and photovoltaic electricity*)

### Projects in Pipe-line:

1. **Solid State Lighting – DST (~ Rs. 20 Lakh)**
2. **OTFT – DST/MCIT (~ Rs. 60 Lakh)**
3. **Development of nanostructured bulkheterojunction organic photovoltaic solar cells - MNRE (~ Rs. 221 Lakh)**
4. **Organic Solar Cells (~ Rs. 3 Lakh) Approved**, Centre for Innovation, Incubation and Entrepreneurship (CIIE) at IIM Ahmedabad
5. **AMOLED Development – DST-Samtel (~Rs. 600 Lakh)**

## URGENT NEEDS AND AREA OF CONCERNS:

### Manpower:

Over the last eight years, SCDT activities have grown and the sustainability of this interdisciplinary group with a product orientation is established beyond doubt. In addition to the faculty group that shares the usual work load within their own departments, a team of technical and support staff is badly needed to sustain the SCDT. A minimum number of staff that is needed to support the activities is given below.

#### QUASI-PERMANENT POST REQUIREMENTS

| Post                    |     | Level                | Job Description   |
|-------------------------|-----|----------------------|---|
| 1. Process Engineer     | one | Research Engineer    | Post Doctoral or Equivalent                             |
| 2. Resident Chemist     | one | Research Scientist   | Post-Doc or M.Sc. (w Exp.)                              |
| 3. Laboratory Manager   | one | Project Associate    | M.Tech with Experience                                  |
| 4. Technical Assistants | two | Technical Assistants | 1. Electronics & Electrical<br>2. Mechanical & Workshop |
| 5. Office Manager       | one | Project assistant    | Documentation, Liaison<br>Purchase, Meetings            |
| 6. Office Help          | one | Project Assistant    | Support Services  |

### Space:

At present, SCDT has no office space for faculty and scientific personnel. Further, there is a big shortage of storage space. Moreover, the laboratory space created has already been fully utilized. The following planned activities would require additional space on urgent basis:

1. Printable Electronics (in coordination with nanotechnology centre)
2. Solar Cells – PDU level activity
3. TFT – AMOLED integration of OLED with Silicon TFT Active Matrix

It requires about six hundred square meters of Lab space.

### Industry Participation:

Though starting the SCDT with a single industry (Samtel) has been extremely beneficial to maintain a focus and speed in the research agenda. For long term sustainability, it is imperative to involve other industries keeping in view the preeminent and most favored position of Samtel and conflict of interests that may arise. Videocon Display Research Team has recently visited the SCDT for collaboration on TFT-LCD research. There are several companies (Moser-Baer PV, Signet Solar, Tata BP etc..) that have shown interest to participate in R&D on Solar Cells with the centre. We have yet to find potential partners in sensor activity.



## **CONCLUDING REMARKS:**

The major achievement of the SCDT is formation of an interdisciplinary research group having a common shared vision to carry out research and development leading to products that may be commercialized for the benefit of the society. The SCDT has set-up a unique model of collaboration with the industry and government agencies.

We have seen a tremendous growth at the SCDT. Setting of a clean room with advanced processing and characterization facilities led to a new level of confidence in the performance of the materials and devices produced in the centre. Vision of fabricating a functional prototype of small display became a reality, strengthening the trust imposed in the tripartite relationship between government, industry and academia.

We are confident that under the able guidance of the National Advisory Committee and Centre Consultative Committee with commitment of the Institute and the untiring efforts of the people@SCDT, we will be able to go beyond the expectations. Critical to this effort will be our continuing commitment to constant and open critique of our activities, nurturing product orientation, broad based interdisciplinarity, and adequate resources for the freedom required for innovation.

## RECENT AWARDS FOR PAPERS FROM SCDT GROUP

- Dr. Y.N. Mohapatra nominated for **Pradeep Sindhu Chair** at IIT Kanpur (2007)
- Dr Satyendra Kumar has won a **SID Presidential Citation** (2007).
- Dr. Ashish Garg was awarded the prestigious **Ramanna Fellowship** by the DST (2006).
- **E-MRS Young Scientist Award 2006** to Mr. Sanjay K Ram (Thesis Advisor: Professor Satyendra Kumar)
- **'Best Poster Awards'** at International Workshop on Physics of Semiconductor Devices (IWPSD 2003) held at I.I.T Chennai, 15-20 December 2003
- **Effect of the CN-PPV & PEDOT/PSS Layers on the performance of PPV/ CN -PPV Polymer Light Emitting Diodes**  
R.S. Anand, Asha Awasthi and J. Narain,  
Department of Electrical Engineering and Samtel R & D Centre, IIT Kanpur
- **DLTS studies of localized states in organic – inorganic semiconductor heterostructures.**  
Samarendra P. Singh, Y. N. Mohapatra, Q. Mohammad, and S. S. Manoharan  
Department of Physics, Department of Chemistry and Samtel Research & Development Centre, IIT Kanpur.
- **First Prize in INTEL STUDENT RESEARCH CONTEST - 2003-04**  
**Electrical and Optical Transients in Organic Light Emitting Diodes: Modeling, Simulations and Measurements**  
Deepak Sharma and Deepak Panwar,  
Department of Electrical Engineering and Samtel R & D Centre, IIT Kanpur.  
(Project Supervised by : Dr. B.Mazhari and Dr.Y.N.Mohapatra)
- **European Materials Research Society Young Scientist Award won by PhD Student.**  
**Stability in Polysilanes for Light Emitting Diodes**  
Asha Sharma, ( Thesis supervised by: Dr. Deepak Gupta and Dr. Monica Katiyar)  
Department of M.M.E and Samtel Research & Development Centre, IIT Kanpur

## **Ph.D. Theses**

1. Molecular Design and Solid State Luminescent Properties of Arylenevinylene-co-pyrrolenevinylenes (AVPVs), Anand Kumar Biswas (MSP), September 2007.
2. Effect of pentacene thickness in organic thin film transistors: measurements and simulations in top & bottom contact devices, Dipti Gupta (MME), June 2007.
3. Electrical & Optical Studies of Zinc Benzothiazole Based Organic Heterostructures, Samarendra Pratap Singh (Physics) , May 2007
4. Photo-Electronic Characterization of PPV Based Light Emitting Polymers: Role of Defects & Disorder, Girija Sankar Samal (MSP), February 2007.
5. Growth and Stability of Organic Semiconducting Thin Films Based on Small Molecules of Tris(8-hydroxyquinoline) Metal Complexes, Vivek Kumar Shukla (Physics), December 2006.
6. Ultraviolet Organic Light Emitting Diodes Based on Polysilanes: Material and Device Degradation Studies, Asha Sharma (MME), August 2006.
7. Influence of Microstructure on Electronic Transport Behavior of Microcrystalline Silicon Films. Sanjay Kumar Ram (Physics), March 2006.
8. Manifestation of nano-crystallites in electronic properties of hydrogenated polymorphous silicon, Vibha Tripathi (Physics) , April 2005.

## **M. Tech Theses**

1. Preparation and Characterization of Carbon Nanotubes and Diamond like Carbon, Durgesh Kumar Rai , (MSP) , October 2007
2. Small Molecule Alq3 based OLEDs and Blue dopants for OLED, Abhishek Sharma (MME), May, 2007
3. Imidazolin-5-one molecule based organic solar cell, Vibhor Jain (EE), May 2007
4. Study of thermal annealing effects on P3HT/PCBM bulk heterojunction organic solar cells, Vinod Pagare, (EE), May 2007
5. Characterization and Fabrication of Organic Thin Film Transistor Using Composite Dielectric of PMMA and Alumina, Vinay Budhraj, (MSP), May 2007
6. Fabrication and Characterization of Pentacene Based Organic Thin Film Transistor (OTFT) With PMMA Dielectric, Arvind Kumar (EE), May 2007.
7. BiFeO<sub>3</sub>-PbTiO<sub>3</sub> Thin Films for High Temperature Sensors, S. Kar, (MME) May, 2007.
8. Mechanical activation Synthesis of Multiferroic BiFeO<sub>3</sub> Ceramics and detailed characterization, T. Harikishan (MME), May 2007
9. Novel low temperature Synthesis and Characterization of nanocrystalline ferroelectric bismuth titanate particles, P. Prakash, (MME), May 2007
10. Electrical Pulse Characterization of Polymer Light Emitting Diodes (PLED) & Measurement of Carrier Mobility, Rajneesh Verma, (MSP), July 2006.
11. Analysis of Contact Resistance of Top Contact OFET through Two-Dimensional Numerical Simulations, Abhinav Sharma (EE), May 2006.
12. Comparative Study of Organic Solar Cells based on MEHPPV/CNPPV and MEHPPV/PCBM, Amruta Bhat (EE), May 2006.
13. Simulation and Analysis of Bi-Layer Organic Solar Cells, Sachin Kumar, (EE), May 2006.
14. Effect of built in potential on the performance of bi-layer organic solar cell, S.K. Khaja (EE), May 2006.
15. A Study of P3HT/PCBM Bulk Hetero-Junction Organic Solar Cells, Dipesh Bajaj (EE), May 2006.

16. Fabrication and Characterization of Pentacene based Organic Thin Film Transistor on PMMA dielectric, Ashish Saini, (EE), May 2006.
17. Techniques for Improving Copying Accuracy & Threshold Voltage sensitivity in Current Driven Active Matrix Organic Light Emitting Display, D.K.Gupta, (EE), May 2006.
18. Study of cathodes and other properties of properties of polyfluorene based polymer light emitting diodes, Wg.Cdr.Ashish Sud, (EE), May 2006.
19. Fabrication & Characterization of Nearly-All-Organic TFT with PMMA as gate dielectric, Amit K.Chouksey (EE), May 2006.
20. "Case studies on Device & Material characterization for polymer light emitting diode applications: Role of charge balance on phosphorescent PLED efficiency & Metal-organic interface", Sanjeev Singh (MME), July 2005.
21. "Study of Optoelectronic Properties of Polysilanes" Srinivas Prasad Sista, August 2005.
22. "A study of charge injection in ITO/PEDOT/MEH-PPV/Ca/Al PLEDs and Lift-off process in positive photo resist", Talari Manojaya (EE), August 2005
23. "Pentacene Based OTFT Inverter Circuits on Flexible Substrates" Harshal Anant Sakhale, (Electrical Engineering), July 2005,
24. "Degradation Studies of Polymer Light Emitting Diodes under electrical stress", Sharat Chandra (Materials Science Programme), June 2005.
25. "MEHPPV/CNPPV based solar cells", Bodh Raj Gautam (Electrical Engineering), May 2005
26. "Angular and Spectral dependence due to layered structure in Organic Light Emitting Diodes", Ravi Kumar M.N (Electrical Engineering), May 2005.
27. "Efficient Organic Light-Emitting Diodes Employing Mobility Hetero-Structure", Sudhir Bapna (Electrical Engineering), May 2005.
28. "Study of Organic Insulator-Semiconductor Interface in Thin Film Transistors," Aarti Gupta (Electrical Engineering), May 2005.
29. "Modeling of Carrier Blocking and Recombination in Bilayer Organic Light Emitting Diode", Saurabh Sharma (Electrical Engineering), May 2005.
30. "A Study of Organic Semiconductor Polymer Material and Device Structures for Application in Optical Detectors" Sheetal Liladhar Barai (Electrical Engineering), May 2005.
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33. "Fabrication and Characterization of single layer Polymer Light Emitting Diodes," Pavan Kumar Gudavalleti, 2003.
34. "Optical Modeling of Organic Light Emitting Diodes' Pradeep Kumar, July 2003
35. "Pentacene Thin Films for Organic TFTs" Girish Kumar Gupta, (July 2003)
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## Patents Filed from SCDT

1. "Low temperature Synthesis of Nd-doped Bismuth Titanate Nanoparticles" Inventors: Dr. Ashish Garg Patent Application No. **804/DEL/2007**.
2. "Room Temperature Synthesis of Nanocrystalline Hydroxyapatite Ceramics", Inventors: Dr. Ashish Garg Patent Application under consideration.
3. New Optoelectronic Device, Inventors: Vibhor Jain, R. Gurunath, Gitalee Bhattachargya, Basanta Kumar Rajbongshi, Arun Tej Mallajosyula and Dr. S.Sundar K. Iyer , Patent Application No, **1231/DEL/2007**, Dated: 07-06-2007.
4. Organic photovoltaic cells with thin films of carbon nano-tubes p-n junctions, Inventors: Dr. S.Sundar K. Iyer and Arun Tej Mallajosyula Patent Application No, **933/Del/2006**, Dated: 31-03-2006.
5. Transfer of Power to contact-less Smart Cards with light from the reader, Inventors: Dr. S.Sundar K. Iyer, Patent Application **2190/DEL/2005** Dated: 17-08-2005
6. UV and white light emission from polysilane based OLEDs at room temperature, Inventors : Dr. Monica Katiyar, Ms. Asha Sharma, Patent Application No. **1532/DEL/2005** Dated: 14-06-2005
7. Variable threshold voltage in proximally located MOSFETs by controlling buried oxide and location below the transistor, Inventors: Dr. S Sundar Kumar Iyer, Dr. Baquer Mazhari , Patent Application No. **2056/DEL/2005** Dated: 23-08-2005.
8. A New Poly-Silicon AMOLED Self-Biased Cascode Pixel Circuit with Highly Linear Transfer Characteristics, Inventors: Baquer Mazhari, Himanshu Joshi and Shashi Bhusan Singh, Patent Application No. **1774/DEL/2004**.
9. Organic Thin Film Transistors with vertical source and drain separation., Inventors: Deepak Gupta, S. S. K. Iyer, Monica Katiyar, and Dipti Gupta, Patent Application No. **1775/DEL/2004**.
10. White Light Emitting Zinc based OLED, Inventors: Y. N. Mohapatra, S. P. Singh, S. S. Manoharan, and Q. Mohammad, Patent Application No. **1776/DEL/2004**.

## Book chapter

S. Panda, S. Pyarajan, "Lab-on-chip Devices for Protein Analysis", Encyclopedia of Microfluidics and Nanofluidics, Ed. D.-Q. Li, Springer-Verlag (accepted - to appear in 2008)

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1. Vibhor Jain, Basanta Kumar Rajbongshi, Arun Tej Mallajosyula, Gitalee Bhattacharjya, S Sundar Kumar Iyer and Gurunath Ramanathan, "Photovoltaic Effect in Single Layer Organic Solar Cell Devices Fabricated with Two New Imidazolin-5-one Molecules", Solar Energy Materials and Solar Cells, 2008 (accepted).
2. Asha Sharma, Monica Katiyar, Deepak, Sanjeev K. Shukla and Shu Seki, "Effect of ambient, excitation intensity and wavelength, and chemical structure on photodegradation in polysilanes", Journal of Applied Physics 102, 104902 (2007)
3. Asha Sharma, Monica Katiyar, Deepak and Shu Seki, "Polysilane based organic light emitting diodes: simultaneous ultraviolet and visible emission", Journal of Applied Physics 102, 084506 (2007)
4. Vibha Tripathi, and Y. N. Mohapatra, P. Roca i Cabarrocas, Electrical Manifestation of nanocrystallites embedded in nanostructured hydrogenated Silicon, to be submitted Journal of Applied Physics 2007.
5. Vibha Tripathi, Vivek Shukla, Debjit Datta, Girija Sankar Samal, Satyendra Kumar, Structure and properties of Electroluminescent Zinc(II) bis(8-hydroxyquinoline) thin films and devices, Submitted to Journal of Applied Physics (2007).
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