Centre of Excellence (CoE)
on
"Advanced Polymeric Materials"
at
Department of Materials Science and Engineering, IIT Delhi
(Formerly Centre for Polymer Science and Engineering)

1. Brief Note on The Project work:

Thematically, the project is first of its kind attempt to reach at detailed understanding of the processing and fabrication of advanced composites and nanocomposites and their related consequences on the structure-property correlation of other allied multiphase polymer based micro and nanostructured materials for various structural and functional application, at the national level. The structural performance aspects related to fire/flame resistance, thermo-mechanical behaviour, thermal energy dissipation, time and temperature dependent load sensitivity of composite material such as creep and stress relaxation behaviour, size scale influence on mechanical properties, dielectric relaxation behaviour of composite in controlled and exposed condition and fabrication of real –time component i.e. beams/bars with optimal property combinations for structural application is critically investigated. The project on one hand led to training of manpower/human resource , while on the other hand the CoE showcase the capability of extending future possibilities to Indian industry interested in exploring new technology solution. Further the knowledge and technological knowhow emerged from the project is disseminated by organising conferences and workshops.

Objectives and Scope

As a part of CoE, both basic research and technology development for structural application would be taken up in the area of advanced composites/nanocomposites materials keeping in view of environment, energy and other civil construction sectors. The CoE also brings together expertise from faculty members engaged in diverse polymer research activates to initiate projects in specific areas. Additionally, the centre would attempt to help industry in development of new technologies/products in theme areas. It is the objective of the centre to create trained manpower that can be absorbed by the industry to help in research, product and process development in the area of composite and nanocomposite.

Project Outcomes and Tentative Deliverables

- Advanced composite materials for structural application with tribological interfaces
- Toughened composites/ nanocomposites for structural application.
- Light weight composite foams for roof structures.
- Enhanced barrier resistance composites/nanocomposite plates/films/slabs for structural cladding and concealing application.
- Toughened termite and water resistant durable composites and nanocomposites for make-shift structures.
- Wood-plastic composite with functional nano-fillers for enhanced durability and mechanical strength
- Engineered structural composites for acoustic properties

2. Advantages of Project Work:

- Availability of high-end polymer /plastic material characterization facility: Installed equipment under CoE and beyond.. e.g. CRF at IITD
- Platform to collaborate and conglomerate for technology and innovation: industry-academia partnership
- Demonstrations/ Training/ Awareness for Researchers, Scientists, Students, Technical staffs, Quality control experts from Industry and Interested work force from elsewhere
- Industry-academia partnership for demand based progressive innovation engaged in diverse polymer research activities to initiate projects in specific areas
- By creating dedicated research facility for structural composites for environment, energy and other civil construction sectors
- By helping industry in development of new technologies/ products in theme areas to create trained manpower that can be absorbed by the industry to help in research, product and process development in area of composites and nanocomposites.

3. Agreements made with following for technology transfer/ commercialization of the technology

- "Micro-fibrilated Fibre" for Start-up Company - Celligo Natural Fibres Pvt. Ltd. (under "Ph.D Incubation Program" of IIT Delhi)

4. Publications on the Project:

- Kaur, Banpreet, et al. "Design and synthesis of highly twisted phenanthroimidazole substituted blue-emitting truxene based fluorescent chromophores." *New Journal of Chemistry* 43.5 (2019): 2278-2288.
- Singh, Vishwa Pratap, et al. "Polyethylene/sepiolite clay nanocomposites: effect of clay content, compatibilizer polarity, and molar mass on viscoelastic and dynamic mechanical properties." *Journal of Applied Polymer Science* 134.33 (2017): 45197.
- Kaur, Banpreet, et al. "Solution processable truxene based blue emitters: Synthesis, characterization and electroluminescence studies." *Journal of Luminescence* 196 (2018): 511-519.
- Ray, Alok R., and B. K. Satapathy. *Studies on filled acrylate based dental restorative composites*. Diss. 2018.
- Nehra, Ranjana, Saurindra Nath Maiti, and Josemon Jacob. "Analytical interpretations of static and dynamic mechanical properties of thermoplastic elastomer toughened PLA blends." *Journal of Applied Polymer Science* 135.1 (2018): 45644.
- Sabapathy, S. *Studies on co2-induced crystallization and foaming behaviour of poly (lactic acid)/clay nanocomposites*. Diss. 2018.
- Kaur, Banpreet, et al. "Design, Synthesis and Selective Functionalization of a Rigid, Truxene Derived Pure Blue-Emitting Chromophore." *ChemistrySelect* 5.1 (2020): 109-116.

- **Sankarpandi S**., Park C. B., and Ghosh A. K, "CO2-Induced Crystal engineering of Polylactide and the development of a polymeric nacreous microstructure", Polymer International, 2017, DOI: 10.1002/pi.5417

5. Details of Patents granted for the project :

- "Process for preparing de-lignified micro-fibrillated fibre" Indian Patent Application No. 201811049740 dated on December, 2018.

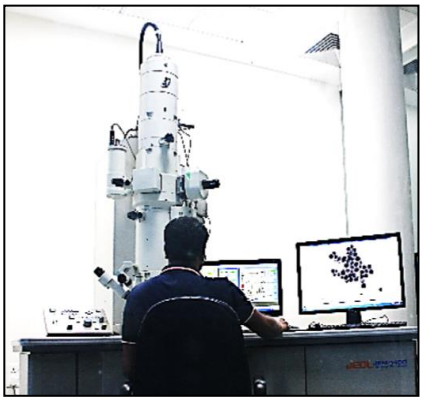
6. Equipment/ Machines available at CoE:

- Vector Network Analyzer (Agilent E8362B Vector Network Analyzer (VNA) in the microwave frequency range of 8.12.4 GHz (X-Band), 12.4–18 GHz (Ku-band) and 18-26 GHz (K Band)) has been installed and is in full use by students and researchers at the moment.
- Transmission Electron Microscope (TEM) has been installed in the newly created Central facility at the institute.
- Atomic Force Microscope (AFM) is procured and installed in the newly created lab.
- Fluorescent Microscope procured and installed.
- WVTR/OTR procured and installed
- Advanced Polymeric Compounding Machine procured and installed

7. Facilities available at CoE:

Transmission Electron Microscope (TEM) Lab - Jeol JEM - 1400 (Model); 120 KV

- Maximum point resolution - 0.4 nm
- Maximum magnification - 12 lacs
- Facilitated with EDX
- It can be used for a variety of metallic and non-metallic
- materials
- Location: Room no: MS108, TEM lab.
- Cost: US$. 2,90,000. (Rs.1,98,87475.00)



Atomic Force Microscopy (AFM)-Nanomagnetics hpAFM System

- Large area scanner: 105
- Small area scanner: 104
- AFM head: 106
- STM head: 136
- Aqua head: 115

WVTR/OTR

Water Vapor/Oxygen Transmission Rate is the steady state rate at which water vapor/ oxygen permeates through a film at specified conditions of temperature and relative humidity. Values are expressed in g/m^2/24 hr and cc/m^2/24 hr respectively.

PERMATRAN-W® Model 3/34

A stand-alone fully automated water vapor transmission rate (WVTR) system. Ideal for those who need fast and accurate results. Easy to use for those new to permeation while offering the features needed for advanced users. Automatic maintenance of RH, temperature, pressure and flow. Complies with ASTM F-1249, JIS K7129 films and TAPPI T557. Ability to test in the same range as the PERMATRAN-W model 3/33 G.

- **Range**: (0.005-100) g/(m^2.24hr)
- **Repeatability:** ±0.005 g/(m^2·24hr) or 2% of reading whichever is greater at 50 cm^2
- **Resolution:** 0.001 g/(m^2.24hr)
- **Temperature test range:** 10°Cto 40°C ±0.2 °C
- **Film test cells per module:** 2 x 50 cm^2 (pneumatic clamping cells)
- **Package testing:** Optional package testing adapter cells available
- **Relative Humidity Range (RH):**
  - Films - 0%, 5% – 90% and 100%
  - Carrier gas - Not controlled by instrument - Use Dry Nitrogen
  - Packages - Ambient or controlled by environmental chamber
- **Test sample size:**
  - Films - 4.0 in x 4.0 in (10.2 cm x 10.2 cm)
  - Packages - Up to 3 liters per package

OX-TRAN® Model 2/22 H

A stand-alone, fully automatic high barrier oxygen transmission rate system. Ideal for those new to 2OX-TRAN 2/22 was designed specifically to improve throughput, increase your labs efficiency, and streamline your operations. Complies with ASTM D3985, F1927 and F1307. DIN 53380 films. JIS K7126 films. ISO CD 15105-2. 21 CFR Part 11 compliant - optional.

- **Range**: Unmasked – (0.05-200) cc/(m^2.24hr)
- Masked – (0.5-2000) cc/(m^2.24hr)
- **Repeatability:** ±0.02 cc/(m^2·24hr) or 1% of reading whichever is greater
- **Resolution:** 0.02 cc/(m^2·24hr)
- **Temperature test range:** 10°C – 40°C ±0.2°C
- **Film test cells per module:** 2 x 50 cm^2 (pneumatic clamping cells)
- **Package testing:** Optional package testing adapter cells available
- **Relative Humidity Range (RH):**
  - Carrier gas - 0% – 90% ±3%
  - Test gas - 0% – 90% ±3%
  - Packages- Ambient
- **Test sample size:**
  - Films - 4.0 in x 4.0 in (10.2 cm x 10.2 cm)
  - Packages - Up to 3 liters per package

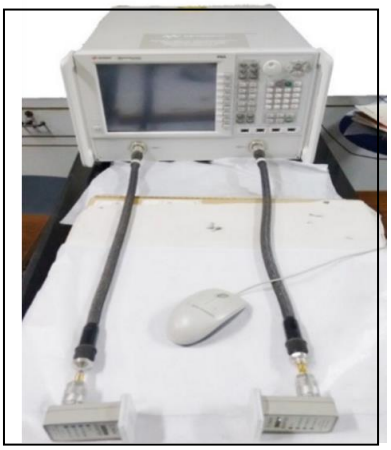
Advanced Polymer Compounding Machine

The machine was equipped with following accessories:

- HAAKE PolyLab OS with specially designed foaming screw
- HAAKE Rheomix OS
- Roll Haul off unit
- Chiller unit
- Static mixer
- Software HAAKE PolySoft OS

Vector Network Analyzer (VNA)

The Electromagnetic interference shielding effectiveness and dielectric properties of polymer composites are carried out on an Agilent N5224A Vector Network Analyzer in a microwave range of various frequency (bands) as follows:

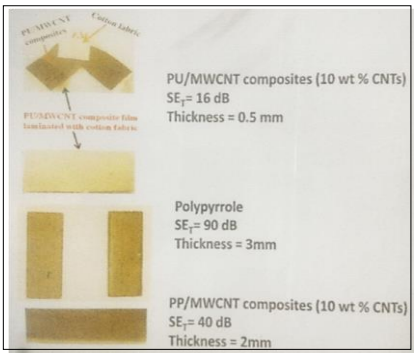


Band	Frequency range (GHz)
X-Band	8.2 to 40 GHz
Ku-Band	12.4-18 GHz
K- Band	18-26.6
Ka-Band	26.5-40

Fluorescent Microscopy

Fluorescent microscopy with capability of characterizing the samples in transmission and reflection modes was purchased recently. This instrument is compatible with bright field, dark field, phase contrast, polarizer-analyzer and fluorescence applications.

- Model No. : Leica (DM-2500)



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