



BMS COLLEGE OF ENGINEERING, BANGALORE-560 019

[Autonomous College under VTU]

TECHNICAL EDUCATION QUALITY IMPROVEMENT PROGRAMME -1.2.1

Centre of Excellence in Advanced Materials Research

Action Plan drawn based on the Key Concerns & Recommendations made in the review meeting conducted by the NPIU on 30.5.14

Formulation & Exercising Good Practices:

- Extend the facilities of COE to UG, PG & Researchers of BMSCE & other institutions for their R&D work.
- Enhanced interaction with industry and R&D organisations: Principal investigators/ Researchers of the CoE are interacting with experts from **Industry/ R&D organisations like** IISc, NAL, TATA advanced materials, Magod lasers, NOPO Nano technologies, CMTI, CPRI etc. to resolve various issues.
- Interaction with the practising experts from Industry/ R&D organisations to draw the specifications of equipment being procured (SEM, XRD, Abrasive water jet cutting machine, Dual sputtering unit etc).
- Periodical review of the activities by experts from R&D organisations- The first review meeting was held on 6th February, 2014 by Prof K.Chattopadhyay, Dept. Materials Engineering, Indian Institute of Science
- Quarterly meetings of in-house faculties working in the area of materials.
- Conduction of conferences, workshops and seminars in the field of materials.

Key Issues/Concerns

The group has identified the materials to be developed at COE and presented the same in the proposal as follows:

1. Synthesis and characterisation of **Alluminium matrix-Flyash** reinforced composite and **Alluminium matrix-n-ZrO₂** reinforced MMCs.
2. Synthesis and characterisation of **tellurium based chalcogenide glasses in bulk and thin film form** with metal & semiconductor dopant like tin or germanium. The material developed will find applications in Non-Volatile Random Access Memory (NVRAM)



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3. Investigations in to machining capabilities of **Abrasive water jet** in Post processing of MMCs, FRPs.
4. **Polypyrrole-Strontium Arsenate polymer composite** for gas/humidity sensor applications.
5. Synthesis and characterisation of **Carbon nanotubes reinforced FRP for impact resistance applications** in collaborations with R&D organizations
6. Indigenous development and characterization of **non-fossil carrier fluid based magnetorheological fluid for application** under the bonnet of an automobile car in collaborations with R&D organizations.
(The above are developed individually by principal investigators and researchers of COE).

Experts' recommendation: Demonstration of Inherent strength

I. List of publications of all principal investigators of COE

Publications of Dr.M.Ramachandra, Principal Investigator

International / National journals:

1. **Ramachandra.M and Radhakrishna.K** "Synthesis-microstructure-mechanical properties- wear and corrosion behavior of an Al-Si(12%) – Flyash metal matrix composite". *Journal of material science*, Springer science, No.40, (2005) pp5989-5997.
2. **Ramachandra.M and Radhakrishna.K** "Sliding wear, Slurry erosive wear and corrosive wear behavior of Al-Si / SiC_p metal matrix composite". *Journal of material science*, Vol.24, No.2/1, (2006)pp333-349
3. **Ramachandra.M and Radhakrishna.K** "Microstructure, Mechanical properties, wear and corrosion behavior of Al-Si/Flyash composite". *Journal of Material science and technology*, Vol. 21, No.11, Nov (2005) pp1337-1343(7)
4. **Ramachandra.M and Radhakrishna.K** "Comparative study of Chromite-sand and sea-sand properties bonded with alkyde 3-part binder system", *Indian foundry journal*, TP-64, April (1998).
5. **Ramachandra.M and Radhakrishna.K** "Effect of reinforcement of flyash on sliding wear, slurry erosive wear and corrosive wear behavior of aluminium matrix composite". *Journal of Wear*, Elsevier publications, Wear 262 (2007) 1450-1462.



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6. **Ramachandra.M and G.N Lokesh** "Effect of Hardness, Tensile and Wear behavior of Al-4.5 wt% Cu alloy /Flyash/SiC Metal matrix composite". *International journal of Modern Engineering Research, IJMER, V3, ISSUE 1 (2013)*.
7. **Bharathi V, M Ramachandra, S Srinivasa, P Sampathkumaran S Vynatheya and S Seetharamu** " The Wear & Friction Characteristics of Glass-Epoxy Composites for Coal Handling Parts in Thermal Power Plants" **The Journal of CPRI, Vol. 9, No. 4, December 2013 pp. 597-602**
8. **G. N. Lokesh, M. Ramachandra, K. V. Mahendra** "Production of Al-4.5% Cu Alloy Reinforced Fly Ash and SiC Hybrid Composite by Direct Squeeze Casting" **International Journal of Engineering and Technology, V3/2, December 2013, 199-203.**

International Conference presentations (Oral):

1. **Ramachandra.M and Radhakrishna.K** "Stir-casting and comparison of mechanical and wear properties of Al(Si12%)–SiC and Al(Si12%)–Flyash metal matrix composite". *International conference on Recent Advances in Material Processing Technology, RAMPT' 05, 23-25 Feb 2005, Kovilpatti, Tamilnadu, India.*
2. **Ramachandra.M and Radhakrishna.K** "Synthesis and evaluation of some properties of Al-Si (7.2%)–Fly ash metal matrix composite". *International conference on theoretical, applied, computational and experimental mechanics, ICTACEM, 26-28, December, 2004, Indian institute of technology-Kharagpur, West Bengal.*
3. **Ramachandra.M and Radhakrishna.K** "Study of sliding wear behaviour of Al-Si (12%)–SiC metal Matrix composite synthesized using vertex method". **International Symposium of Research Students on Materials Science and Engineering (ISRS-2004)** December 20-22, 2004, Indian institute of technology-Madras, Chennai.
4. **Ramachandra.M and Radhakrishna.K** "Processing – Mechanical and wear properties of aluminium based metal matrix composite synthesized using vortex method". *International conference on mechanical engineering, ICME2003 DHAKA, 26-28 December 2003, Bangladesh University of engineering and technology. Dhaka, Bangladesh.*
5. **Ramachandra.M and Radhakrishna.K** "Evaluation and comparison of mechanical and wear properties of Al-Si (12.2%)–Graphite and flyash reinforced metal matrix composite synthesized using stir casting method". *World Foundry Congress, Horogate, UK, June 5,6and 7, 2006.*
6. **Ramachandra.M and Radhakrishna.K** "Synthesis, mechanical properties, wear and corrosion behaviour of Al-Si/Graphite metal matrix composite". *World Foundry Congress, Horogate, UK, June 5,6and 7, 2006.*



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7. **Ramachandra.M and Radhakrishna.K** "Production and Evaluation of Sliding and slurry erosive wear properties of Al-Graphite-flyash reinforced hybrid metal matrix composite" *International Conference on Industrial Tribology* – Nov30-Dec 2, 2006, IISc, Bangalore.
8. **Ramachandra.M and Radhakrishna.K** "Sliding and slurry erosive wear studies on Al-SiC metal matrix composite" *International Conference on Industrial Tribology* – Nov 6-8, 2008, NewDelhi.
9. **Ramachandra M and Lokesh G N** "Increasing the thermal efficiency of an air cooled engine" INCRAME 2011, Dr.MGR Educational and Research Institute University, Chennai
10. **Ramachandra M and Mahadevaswamy.M** "Air Ejector Technique for Decorative Artistic Glass Items", International conference on Advanced Materials, Manufacturing, Management and Thermal Sciences, AMMMT-2010, 18th to 19th November 2010.
11. **Ramachandra M and Bharathi V** "Evaluation of wear property of Al- Fly ash metal matrix composite synthesized using squeeze casting" 8th *International Conference on Industrial Tribology* – Dec 7-9, 2012, Pune (India).
12. **Ramachandra M and Prasad KNP** "Analysis of processing parameters and percentage of flyash affecting the dry sand abrasion wear of aluminium flyash metal matrix composites by using design of experiments" 8th International Conference on Industrial Tribology – Dec 7-9, 2012, Pune (India).

Publications of Dr.S.Srinivas, Principal Investigator

International Journals

1. **Dr.S.Srinivas, and Dr.Ramesh Babu, N.** Penetration ability of abrasive waterjets in cutting of aluminum-silicon carbide particulate metal matrix composites, *Machining Science and Technology:An International Journal*, 16:3, Aug 2012, pp 337-354
2. **Dr. S.Srinivas, and Dr. Ramesh Babu, N.** Role of garnet and silicon carbide abrasives in abrasive waterjet cutting of aluminum-silicon carbide particulate metal matrix composites, *Int. J. of Applied Research in Mechanical Engg*, V1, Issue 1, 2011, pp 109-122, ISSN: 2231 –5950
3. **S.Srinivas, and Ramesh Babu, N.** An analytical model for predicting depth of cut in abrasive water jet cutting of ductile materials considering the deflection of jet in lateral direction, *Int. J. of Abrasive Tech*, V2,No.3, 2009, pp 259-278

International Conferences

1. **Dr. S.Srinivas, and Dr. Ramesh Babu, N,** "ABRASIVE WATERJET – A TOOL FOR MANUFACTURING" Int. Conference on Advanced materials, Manufacturing, Management & Thermal Sciences, 18-19th Nov,



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2010, SIT, Tumkur

2. **S.Srinivas, and Ramesh Babu, N.** An analytical model for predicting depth of cut in abrasive waterjet cutting of ductile materials, Proceedings of the 22nd All India Machine Tool Design and Research Conference, IIT Roorkee, India, Dec 21-23, 2006, pp 863-868
3. **S.Srinivas and B.J. Ranganath.** Selection of optimum values of cutting parameters for CNC program generation using Expert system, Proceedings of Int. Conference on Agile Manufacturing, Bangalore, Feb 22-24,1996, pp 111-115

National Conferences

4. **S.Srinivas and B.J.Ranganath.:** Expert system based cost engineering in metal cutting applications, National seminar on Quality & Reliability Engineering, Jan 19th & 20th, 1995, Annamalai University

Publications of Dr.Chandasree Das, Principal Investigator

1. **Chandasree Das,** G. Mohan Rao and S. Asokan, 'A Comparative Study of Electrical Switching Behavior of Certain Tellurium based Chalcogenide Thin Films for Phase Change Memory (PCM) Applications', **Advanced Materials Research**, 123-125 (2010) 1207.
2. **Chandasree Das,** R. Lokesh, G. Mohan Rao and S. Asokan, 'Electrical switching behavior of amorphous $Al_{23}Te_{77}$ thin film sample', **Journal of Non-Crystalline Solids** (Letter to Editor), 356 (2010) 2203.
3. **Chandasree Das,** G. Mohan Rao and S. Asokan, 'Electrical Switching and Thermal Studies on Bulk Ge-Te-Bi glasses', **Journal of Non-Crystalline Solids**, 357 (2011) 165.
4. **Chandasree Das,** M.G. Mahesha, G. Mohan Rao and S. Asokan, 'Electrical Switching Studies On Amorphous Ge-Te-Sn Thin Films', 55th DAE Solid State Physics Symposium, 2010, **AIP Conference Proceedings**, 1349 (2011) 633.
5. **Chandasree Das,** M.G. Mahesha, G. Mohan Rao and S. Asokan, 'Electrical Switching and optical studies on Amorphous $Ge_xSe_{35-x}Te_{65}$ Thin films', **Thin Solid Films**, 520 (2012) 2278.
6. **Chandasree Das,** G. Mohan Rao and S. Asokan, 'The Electrical Switching and Thermal Behavior of Bulk $Ge_{15}Te_{85-x}Sn_x$ and $Ge_{17}Te_{83-x}Sn_x$ glasses', **Journal of Non-Crystalline Solids**, 358 (2012) 224.
7. **Chandasree Das,** M.G. Mahesha, G. Mohan Rao and S. Asokan, 'Studies on Electrical Switching Behavior and Optical Band gap of Amorphous Ge-Te-Sn Thin films', **Applied Physics A: Material Science & Processing**, 106 (2012) 989.
8. **Chandasree Das,** Kiran Mangalampalli, U. Ramamurty and S. Asokan, 'Manifestation of Intermediate Phase in Mechanical Properties:Nano-indentation Studies on Ge-Te-Si Bulk Chalcogenide Glasses', **Solid**



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State Communications, 152 (2012) 2181.

Conference Presentations (oral)

1. "A comparative study of electrical switching behavior of certain Tellurium based chalcogenide thin films for phase change memory (PCM) Applications" in 3rd International Conference on Multi-functional Materials and Structures. Held at Jeonju, South Korea, from September 14th – 18th 2010.
2. "Electrical Switching and Optical Band gap Studies of Amorphous Ge-Te-Sn Thin Films" in International Conference on Materials for Advanced Technologies, Held at Singapore, from June 26th – July 1st 2011.

Publications of Dr. Murugendrappa M.V, Principal Investigator

1. Conductivity and DSC Studies of Polyethylene glycol and its salt complexes, **M V Murugendrappa, Syed Khasim and M V N Ambika Prasad**. Ind. J. Engg. & Mat. Sci., Vol. 7, Oct. – Nov. 2000, pp 456 – 458
2. Surface Morphology and ac conductivity behavior of polypyrrole – fly ash composites **M V Murugendrappa, Syed Khasim, M Revanasiddappa, S C Raghavendra and M V N Ambika Prasad**. Solid State Physics (India) Vol. 46, 2003, pp 713 – 714
3. Synthesis and AC Conductivity Studies of Polypyrrole –BaTiO₃ Composites,**M V Murugendrappa, Syed Khasim, M Revanasiddappa and M V N Ambika Prasad**. Ferroelectrics and Dielectrics, Vol. 1, Nov. 2004, pp 14 – 18
4. Synthesis, Characterization and Dielectric Properties of Polianiline – Dysprosium Oxide Composites, **K Sangashetty, Syed khasim, P Narasimha, Murugendrappa M V, M Revasiddappa, S C Raghavendra and M V N Ambika Prasad**. Ferroelectrics and Dielectrics, Vol. 1, Nov. 2004, pp 43 – 46
5. Synthesis characterization and conductivity studies of polypyrrole – fly ash composites, **M V Murugendrappa, Syed Khasim and M V N Ambika Prasad**. Bull. Mater. Sci., Vol. 28 No. 6 Oct. 2005, pp 565 – 569
6. Synthesis, Characterization and dc conductivity studies of polypyrrole – BaTiO₃ composites, **M V Murugendrappa and M V N Ambika Prasad**. Mater. Sci. an Ind. J., Vol. 2, Issue 1, 2006, pp 1 – 6
7. Dielectric spectroscopy of polypyrrole – γ – Fe₂O₃ composites, **M V Murugendrappa and M V N Ambika Prasad**. Mater. Res. Bull., Vol. 41, 2006, pp 1364 – 69
8. Chemical synthesis, characterization and dc conductivity studies of polypyrrole – – Fe₂O₃ composites, **M V Murugendrappa and M V N Ambika Prasad**. J. Appl. Poly. Sci., Vol 103, 2007, pp 2797 – 2801
9. Synthesis, Characterization and ac conductivity studies of polypyrrole – vanadium pentaoxide



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composites, **M V Murugendrappa, Ameena Paeveen and M V N Ambika Prasad**. Mater. Sci. & Engg. A., Vol. 459, Issues 1-2, 2007, pp 371 – 374.

National and International Conferences

1. Dielectric Studies of Polyethylene glycol and its salt complexes, **M V Murugendrappa, Syed Khasim and M V N Ambika Prasad**, Presented in The Material Research Society of India, Gujarat Chapter, 11th Annual General Meeting of MRSI conducted at M S University, Baroda (Gujarat) during 3rd to 5th Feb. 2000.
2. Conductivity and DSC Studies of Polyethylene glycol and its salt complexes, **M V Murugendrappa, Syed Khasim and M V N Ambika Prasad**. Presented in National Conference on Materials Science: Trends & Future (MSTF-2000) held at Sant Longowal Institute of Engineering and Technology, Longowal (Punjab) during 24th to 25th Feb. 2000.
3. Impedance Studies of Polyethylene glycol and its salt complexes, **M V Murugendrappa, Syed Khasim and M V N Ambika Prasad**. Presented in The National Seminar on Major Landmarks in Physics of 20th Century, conducted at Department of Physics, Gulbarga University, Gulbarga (Karnataka) on 15th March. 2000.
4. Surface Morphology and ac conductivity behavior of polypyrrole – fly ash composites, **M V Murugendrappa, Syed Khasim, M Revanasiddappa, S C Raghavendra and M V N Ambika Prasad**. Presented in DAE Solid State Physics Symposium held at Jiwaji University, Gwalior during 26th to 30th Dec. 2003.
5. Synthesis and Conductivity Studies of Polypyrrole – γ -Fe₂O₃ Composites, **M V Murugendrappa, Syed Khasim, M Revanasiddappa and M V N Ambika Prasad**. Presented in National Conference on Current Trends in Condensed Matter Research held at University of Arts and Science College, Warangal, AP during 20th to 22nd Sept. 2004.
6. Synthesis and AC Conductivity Studies of Polypyrrole –BaTiO₃ Composites **M V Murugendrappa, Syed Khasim, M Revanasiddappa and M V N Ambika Prasad**. Presented in XIII National Seminar on Ferroelectrics and Dielectrics held at Department of Physics and Astrophysics, University of Delhi, New-Delhi during 23rd to 25th Nov. 2004.
7. Transport Properties of Polianiline – BaTiO₃ Composites, **Syed khasim, Murugendrappa M V, Sangashetty K and M V N Ambika Prasad**. Presented in XIII National Seminar on Ferroelectrics and Dielectrics held at Department of Physics and Astrophysics, University of Delhi, New-Delhi from 23rd to



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25th Nov. 2004.

8. Synthesis, Characterization and Dielectric Properties of Polyaniline – Dysprosium Oxide Composites, **K Sangashetty, Syed khasim, P Narasimha, Murugendrappa M V, M Revasiddappa, S C Raghavendra and M V N Ambika Prasad**. Presented in XIII National Seminar on Ferroelectrics and Dielectrics held at Department of Physics and Astrophysics, University of Delhi, New-Delhi from 23rd to 25th Nov. 2004.
9. Synthesis and Characterization of Polypyrrole – nano Fly ash Composites, **M V Murugendrappa, Syed Khasim, and M V N Ambika Prasad**. Presented in International Symposium on Advanced Materials and Processing held at Materials Science Center, Indian Institute of Technology, Kharagpur during 6th to 8th Dec. 2004
10. DC Conductivity Studies of Polypyrrole Fly Ash Composites, **Murugendrappa M V, Syed Khasim, Narsimha Parvatikar, Sangashetty K, Raghavendra S. C, Revanasiddappa M and M V. N. Ambika Prasad**. Presented in **16th AGM of MRSI and Symposium on Materials for Automotive Industries held at National Chemical Laboratory, University of Pune, Pune during 9th to 12th Feb. 2005**.
11. Synthesis, Characterization and Transport Properties of Polyaniline Cerium Oxide Composites, **Narsimha Parvatikar, Syed Khasim, Murugendrappa M V, Sangashetty K, Raghavendra S C, Revanasiddappa M and M V N Ambika Prasad**. Presented in **16th AGM of MRSI and Symposium on Materials for Automotive Industries held at National Chemical Laboratory, University of Pune, Pune during 9th to 12th Feb. 2005**.
12. Synthesis, Characterization and Studies of Polypyrrole Vanadium Pentaoxide Composites, **Ameena Parveen, Murugendrappa M V, Narsimha Parvatikar, Syed Khasim, and M V N Ambika Prasad**. Presented in **16th AGM of MRSI and Symposium on Materials for Automotive Industries held at National Chemical Laboratory, University of Pune, Pune during 9th to 12th Feb. 2005**
13. Synthesis, Characterization and DC Conductivity Studies of Polypyrrole – BaTiO₃ Composites, **M V Murugendrappa, M Revanasiddappa and M V N Ambika Prasad**. Presented in National Seminar on Advances in Materials Science (AMS-06) held at Department of Materials Science, Gulbarga University, Gulbarga during 9th to 10th Jan. 2006
14. Magnetic Properties of Polyaniline-Fe₂O₃ Composites, **Syed khasim, Sangashetty K, Murugendrappa M V and M V N Ambika Prasad**, Presented in Seminar on Advances in Materials Science (AMS-06) held at Department of Materials Science, Gulbarga University, Gulbarga during 9th to 10th Jan. 2006
15. Synthesis, Characterization and Studies of Polypyrrole and Vanadium Pentaoxide Composites, **Ameena**



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Parveen, Murugendrappa M V, Narsimha Parvatikar and M V N Ambika Prasad, Presented in Seminar on Advances in Materials Science (AMS-06) held at Department of Materials Science, Gulbarga University, Gulbarga during 9th to 10th Jan. 2006

16. Dielectric Spectroscopy Of Polypyrrole – Batio3 Composites, **Murugendrappa M V and M V N Ambika Prasad, Presented in National conference** on Advances in Materials Science (AMS-2007) held at Department of Materials Science, Gulbarga University, Gulbarga during 27th to 28th Jan. 2007
17. Synthesis and DC conductivity studies of polypyrrole – V2O5 composites, **Murugendrappa M V and M V N Ambika Prasad, Presented in UGC Sponsored National conference** on Recent Trends on Nanoscience and Green Chemistry held at S S Margol College of arts, Science & Commerce, Shahabad, Gulbarga dist. during 23rd to 24th Oct. 2009
18. Synthesis and AC conductivity studies of polypyrrole – V2O5 composites, **Murugendrappa M V and M V N Ambika Prasad, Presented in National Conference on Engineering of Materials through energetic particles (NCEMEP) held at Bahubali College of Engineering, Gommata Nagar, Shravanabelagola, Hassan dist. during 8th to 10th April 2010.**
19. Dielectric spectroscopy of conducting polymer and ferroelectric composites, **Murugendrappa M V and M V N Ambika Prasad, International conference on Recent Advances in Materials, M Science (RAMS – 2012) Karnataka State Higher Education, Council, Bangalore during 6th, 7th and 8th November 2012.**

II. Existing facilities for synthesis and characterisation of materials

Equipment available in Composites R&D Lab
Computerized UTM
Computerized Pin on disc wear testing M/C
Abrasive wear testing M/C
Fog corrosion test equipment
Hydraulic Squeeze press
Electrical resistance furnace (9Kw and 12Kw)
Slurry erosion testing M/c



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Composite -casting Facility



Composite Stir-Squeeze casting Facility



Characterization facility





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Computerised Pin on Disc Wear testing M/C



Computerised UTM



Abrasive wear testing M/C



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Procurement Status

Sl	Item	Estimated Cost (Rs.)	Approved Mode of Procurement	Status
1	Abrasive Water Jet Cutting Machine	90,00,000	NCB	Purchase Orders issued and Customs Duty Exemption Application submitted. [CDE Certificates are expected to be cleared in VTU meeting scheduled on 18/07/2014]
2	Dual Sputtering Equipment	18,00,000	NCB	
3	FTIR Spectroscopy Equipment	10,50,000	NCB	
4	Precision Impedance Analyzer	10,50,000	NCB	
5	XRD Equipment	70,00,000	LIB	Limited International Bidding (LIB) documents reviewed by COE Coordinator and Nodal Officer Procurement. Bid Documents submitted for SPFU/NPIU review and approval
6	Scanning Electron Microscope	1,00,00,000	LIB	

Dr.M.RAMACHANDRA

CO-ORDINATOR, COE