Institution: University of Bolton
Unit of Assessment: 15 –General Engineering

a. Overview

Since RAE 2001, the University has selected the area of General Engineering as one of its major research strengths for investment. Its materials and engineering research strengths have been integrated into a single composite of three main research themes covering the continuum from materials science to engineered materials and related applications in an integrative, interactive, interdisciplinary and synergistic manner. The research is undertaken in Institutes for Materials Research & Innovation (IMRI) and Renewable Energy &Environmental Technologies (IREET) and School of Engineering and Sciences with the themes and groupings:

1. *Innovative materials for environmental technologies (IMET)*
   Fire Materials (FM): **Kandola** (1), **Horrocks** (0.2), **Price** (0.2), **Myler** (0.2), **Halacheva** (0.5)
   Composite Systems (CS): **Myler** (0.8), **Anand** (0.3), **Miraftab** (0.2), **Shah** (0.4)
2. *Biomedical engineering and devices (BMED)*
   Miraftab (0.8), **Rajendran** (1),**Anand** (0.3), **Siores** (0.5), **Shah** (0.2),**Luo** (0.6), **Halacheva** (0.5)
3. *Renewable energy (RE)*
   Shao (1), **Edwards**(1**)**, **Siores**(0.5), **Shah**(0.4), **Soin**(1), **Geng**(1), **Luo**(0.4), **Papadopoulos** (1)

b. Research Strategy

The 2008 RAE submission in 'General Engineering' comprised 10.8 FTE (total number 20) staff members and five research groups: Mechanical Structures (MSG), Engineered Textiles (ETG), Fire Materials (FM), Smart Materials and Systems (SMSG) and Biohealth and Medical Devices Group (BMDG). Of these, one had world-leading stature (Fire Materials Group), two had small teams with leading international presence (auxetics and crashworthiness), while others were emerging groups. Our rating was: 10% staff: 4*, 15%: 3*, 50%: 2* and 25%: 1*. Building on this success, the established groups have maintained their lead while emerging groups have become established and a new area, Renewable Energy, has been developed. These restructured research groups comprise 16 (14 FTE) staff members, 2 current PDRAs (plus 2 joining in Jan 2014 and total 18 funded over the REF period), 1 senior scientific officer and 47 (35 FTE, 5 PT and 7 by publication) PhD students. Groups work interactively and synergistically, a good example being research into composites which considers fundamental materials behaviour (eg resin modification, introduction of nanoparticulates / piezoelectric reinforcements etc) through to performance (fire resistance, impact) and applications (marine, aerospace, automotive). Similarly, research into energy harvesting hybrid fibres involves photovoltaic elements development, inclusion into polymers, extrusion of piezoelectric fibres and producing fabrics. Predictive modelling techniques, both for processing/designing and performance evaluation are used in all areas of research. The combined success of the group is demonstrated by:

- >340 publications in refereed journals, >300 conference contributions;
- 26 patent applications/patents granted;
- £2.96m research income;
- 26 postgraduate students achieving the award of PhD;
- 4 candidates achieving the award of PhD-by Published Works, a scheme started in 2004 where the candidates are senior technical managers in industry and commerce, and carry out research on work-based projects within an academic framework.

The main objective for the next 5 years is to build on these strengths and expect to maintain/develop world lead in the respective fields. To replace researchers who moved to other institutions in the last year, the University has appointed 13 new lecturers during the period May – October 2013 with research interests complementary to these groups: 3 with electrical and electronics (**See, Ghani, Yang**), 1 with polymer chemistry (**Halacheva)**, 1 with modelling (**Papadopoulos),** 1 with materials physics (**Makridis),** 2 with civil engineering (**Boulbibane, Osman),** 1 with telemetry **(Paraskevas)** and 4 with biology/biomedical engineering (**Pogson, Baldwin, Motsoukas, Thomas)** backgrounds. While only 2 of these new appointees have been included in this REF submission, all of them will contribute to development of these groups and will be trained as future leaders in their respective fields. To achieve this, the new appointees are

being mentored by senior researchers/group leaders, the University's Research and Graduate School and the Research Directors. The University also encourages them in international collaboration by having joint PhD students with other institutions, particularly in China and India. The involvement of new staff members for future developments discussed below reflects the growth in overall research population during the period.

Innovative materials for environmental technologies (IMET)

Fire Materials (FM)

This group, comprising 4 professors (**Kandola, Horrocks, Price, Myler**), 1 research fellow (**Smart**), 1 part time SSO (**Milnes**), 1 visiting professor (**Ebdon**) and a recently appointed lecturer (**Halacheva**), has maintained its world-leading stature over this period. The group started by **Horrocks** in 1980s with research interest in flame retardant textiles was taken over by **Kandola** in 2005, who broadened the scope to include fibre-reinforced composites for structural applications, involving **Myler** for mechanics of flame retarded composites. **Price** with expertise in fire chemistry joined Bolton in 2003 (previously at Salford). After 15 years of collaborative relationship with **Ebdon** at Sheffield with expertise in polymer chemistry, the group appointed him as a visiting Professor at Bolton in 2010. Over this REF period one research fellow (**Smart),** 6 post docs, 1 RA, 23 visiting researchers and 10 PhD students have been working on multidisciplinary projects ranging from polymer modification, the development of novel environmentally sustainable flame retardants (FRs), the use of conventional FRs with novel synergists in fibre-forming polymers and biopolymers, the evaluation of FR properties of chemically/physically modified polymers and their mechanisms of action, and mechanical property changes of flame retarded polymers during and after exposure to heat / fire and associated modelling. The group has published 75 papers in peer reviewed journals, two edited books on 'Advances in fire retardant materials (Horrocks, Price, 2008)' and 'Update on flame retardant textiles (Horrocks et al, 2013)' and 26 chapters in different books. The group hosts (**Horrocks** as Chairman and **Smart** as secretary**)** the UK Fire and Materials Discussion Group, (FMDG) (a sub-set of the Materials interest group within the Society of Chemical Industry, SCI), originally established by **Price** at Salford in the mid-1990s) as a forum to promote the research and development of flame retardant materials within UK academia and industry. **Kandola** as vice chair of the COST (European Cooperation in Science and Technology) action MP 1105 (FLARETEX, 2012-2016), with membership of 21 European countries, networks with other researchers for developing consortia for recently submitted and future EPSRC, TSB and EU project proposals.

The future strategy of the group is to increase the critical mass of FTE researchers in the group and to produce polymers/composites with multifunctional properties. **Halacheva** with a polymer chemistry background has already started working in this area. New lecturers with engineering backgrounds are being engaged.

***Composite systems (CS*)**

The group, in addition to working with the Fire Group on a number of projects, has been active in structural and vehicle crashworthiness of advanced composites for over fifteen years (**Myler** and **Chirwa** (retired, December 2012)) leading to enhanced passenger and pedestrian safety. This has brought international reputation to the group working closely with Universities in China and USA, developing staff and research student exchanges since 2000 and within UK with Aircelle and Aero Composites Ltd. The group also has also an international reputation in auxetic materials (**Alderson and Alderson**, left September 2012). **Anand, Rajendran** and **Shah** work on flexible composites materials and have developed Personnel Protective Equipment (PPE) with **Myler**, semi-permeable protective clothing for UK police and armed forces, composites for body armour and armoured vehicles (in collaboration with Remploy, UK) and slash resistant vests. **Miraftab's** activities in Environmental Engineering are based on use of textile (carpet) wastes in engineering applications including civil/construction and acoustics. He also authored a book on 'Fatigue failure of textile fibres'. The future strategy of this group is to grow in the area of performance automotive structures and motorsports composites. The Group has recently been enhanced with three new lecturers and one technical support officer in this area and an active on-site motorsports development team (RLR) with substantial investment in new laboratory facilities.

The Biomedical engineering and devices (BMED)

The group comprises of 3 professors (**Anand, Siores, Luo**), 1 reader (**Miraftab**) and 2 senior researcher (**Shah**, **Rajendran**). This group works interactively with industry/academia and hospitals largely aiming to develop innovative and smart engineering solutions to medical problems. This group was first established by **Anand** in 1980s with strong focus on medical and apparel textiles, however, since then it has diversified into biomedical/smart materials and smart micro-sensor areas reflecting the expertise of other group members. **Siores** and **Luo** have been instrumental in developing electromagnetic shielding/antennae leading to self-monitoring of carotids, heart, arthritis for early diagnosis, and development of 'lab-on-chip' based on utilisation of ZnO thin films for home diagnosis and virus detections respectively. To build on this expertise, recently 3 new lecturers have been added to the group (**Ghani, Baldwin and Makridis**) with specific expertise in Biological/Neural signal processing, microwave metamaterials and structural biology. **Shah** with polymeric background contributes to this group by developing novel materials for medical devices.
To disseminate new knowledge and expertise, new MSc courses have been developed, which have become a valuable feeder to PhD and post-doctorate programmes. **Miraftab** also leads a British Council-sponsored postgraduate programme of collaboration with Faisalabad National Textile University, Pakistan which involves joint research works, exchange of scholars and joint publications. Part of future strategy of this group, is to engage and involve other overseas institutions in postgraduate studies leading to joint qualification and research outcomes. The group, since last RAE has produced 98 peer reviewed papers, 9 patents (filled and granted) and has contributed to authorship (Advanced Textiles for Woundcare, Rajendran)) and editing of text books (Medical and Healthcare Textiles, Eds Anand, Miraftab and Rajendran).

Renewable Energy (RE),
The RE group consists of 3 professors (**Siores**, **Shao**, **Luo**), 1 reader (**Geng**), 1 Senior Lecturer (**Edwards**), 2 lecturers (**See**, **Papadopoulos**) and 3 research fellows (**Shah**, **Soin**, **Han**). **Siores** through his interest in organic piezoelectric and photovoltaic materials engaged in research/innovation on renewable energy harvesting. Through the University's investment in new talents programme in 2007, **Shao** and **Luo** joined IMRI as professors from the Universities of Brunel and Cambridge respectively and helped in establishing this group as a world-class research team. Their synergistic exploitation of each other's world-class research lines enabled rapid outcomes in pioneering sustainable photovoltaic energy harvesting, using a "designer" approach to develop low-cost oxides/silicides through radical engineering of electronic structures and developing new solar cell architectures using these novel materials. **Geng** joined the team later as a Reader in 2009 with skills in carbon-based materials from Cambridge, where his work was commercialized to launch the UK's first company (Thomas Swan &Co Ltd) manufacturing carbon nanotubes and related materials. **See** and **Papadopoulos** have been appointed as new-blood lecturers in line with the University's long-term strategy to promote sustainable world-class research. The former works on sensor array networks for environmental monitoring and power management, and the latter on modeling of organic photovoltaics and energy harvesting systems. **Soin** works on the fundamental influence of deposition conditions and doping on the microstructure and properties of graphene nanoflakes. Through national/EU/international research grants, the renewable energy group has funded 7 postdoctoral research fellows and 4 visiting scholars and led to its establishment as the Institute for Renewable Energy and Environmental Technologies (IREET) in 2011, with **Shao** as Director. In line with the University's strategy in promoting world-class research in renewable energy and environmental technologies, the critical mass of IREET has recently been increased significantly through the appointment of new-talents lecturers with physics (2), chemistry (3) and electronic engineering (3) backgrounds. These new staff members have been proactively engaged in research and new teaching programmes. The team strives to sustain collaboration with industrial partners and, in addition to their inclusion in EU/TSB research consortia, **Shao** has been helping these companies for their entry into China (e.g. representing the Plasma Quest Ltd on latest TSB China Mission, October 2013).

c. People, including:

I. Staffing strategy and staff development

The University supports the UoA's research plans, especially in strategic areas as exemplified by the recruitment of 1 reader (**Geng**) in nanomaterials and one research fellow (**Soin**) in the RE

group. Both of these positions have been partly supported by the former NWDA-funded Knowledge Centre for Materials Chemistry (KCMC). The 13 new academic appointments (as in Section b) within the School of Engineering and Sciences are linked to their research interests in one of the research groups, thus offering support and development. The University's recruitment and selection policies comply with the European Charter and Code, and are in line with the requirements of the Concordat. An HR Excellence submission is nearing completion. All research positions are job-evaluated and each role aligned to the university' new pay and grading arrangements, which ensure that all researchers are rewarded irrespective of the type and duration of contract. Vacancies are advertised on websites which attract applicants from across EU countries. All person specifications for research posts have the requirement that the researcher has the capability and capacity to develop into an independent researcher. The University has a Personal Development Plan (PDP) process which in 2nd year of the employment encourages post-doctoral researchers to start to make their own applications for funding to develop their future as independent researchers. Each staff member's PDP is reviewed annually through which career development and time and resources for research are negotiated.

The post-doctoral and research fellows are encouraged to teach on MSc courses, are involved in supervisory teams for PhD students with support from a series of supervisor development workshops and are encouraged to be on standing panels set for monitoring students' progress. All post-doctoral and research fellows are supported with and expected to write research proposals as a part of their career development scheme. At the end of their fixed term contract, they are supported to be retained within the group or are helped to find positions elsewhere. To help research fellows establish international collaboration, increase publications and develop their own area of research at the end of the fixed term contracts, IMRI/IREET have introduced a fellowship to help research fellows supervise one PhD student in China, India and other countries. Under this scheme the PhD student works in his own country, supported by a professor from his/her institution. To date three former PDRAs, Dr Sheng (1999-2005, now Professor in University of Chemical Technology, Beijing, China), Dr Kandare (now in RMIT, Melbourne, Australia) and Dr Deli (2010-2012) have had PhD students in the University of Science and Technology, Hefei, China. Similarly Rajendran had a programme with IIT, Delhi. Twelve papers through this scheme have been published during this period which has helped in developing long term, inter-university relationships.

Kandola was invited as a guest Professor in USTC China (2008) and appointed as Visiting Professor, sponsored by the Chinese Academy of Sciences under the Senior International Scientists Scheme (2010-2011). **Kandola** was also invited as a Guest Professor in Nanjing University of Science and Technology, China (2010). **Shao** is international director for the UK-China Centre for Multi-functional Nano-materials (Zhengzhou) and was presented the prestigious Huang Kun Lectureship Award (Chinese Academy of Sciences, 2011). **Geng** was Academic Visiting Scholar for the Frankfurt Institute for Advanced Studies, Germany (2008) and The Annual Lecturer 2011 of Materials Institute, University of Alicante, Spain (2011). **Luo** is Visiting Professor to the Zhejiang University (China), and **Edwards** was visiting professor to the Nanjing University (China). **Anand**, in 2008 was honoured with the Member of the Order of the British Empire (MBE) award, for services to Higher Education and the Textile Industry. Since 2008, he also was nominated as expert in Technical Textiles by the United Nations Industrial Development Organisation (UNIDO), Austria, and has completed assignments in Bangladesh and Philippines. **Shah** is Visiting Professor at Textile Institute of Pakistan and Advisor to Higher Education Commission (Pakistan) for review of their Science and Engineering curricula. **Miraftab** organises and co-chairs rota-based International conferences in textile recycling in collaboration with Georgia Tech, USA and Kyoto University, Japan. **Siores** is the University Provost for Research and Academic Development. He has given many key note addresses at international conferences in China and Europe. Recently he became Chair of the Board of Governors at Athens University, is on the Board of Directors of FibrLec Ltd and as International Evaluator of the Automotive Components, inter-university centre in Hong Kong.

The University's strategy on equality and diversity is reflected by the backgrounds of the submitted staff and those recently appointed. The University's Equal Opportunities and Diversity Policy is

available to all staff via its website and all new staff are taken through the policy at induction. All staff, including research staff, have access to Amian, the University's Employee Assistance programme (EAP) provider which offers 24 hours support and counselling on personal and work related matters. The University has a policy on bullying and harassment and how incidents must be handled through its staff grievance and disciplinary procedures. Research staff have the same intellectual property rights as other staff, unless the particular funding body has imposed special requirements.

c. II. Research students

The PGR recruitment and selection policies comply with the European Charter and Code. All funded PhD vacancies are advertised on websites which attract applicants across EU and beyond. Research student numbers remain at healthy levels, sustained by internal and external studentships and partnerships with external funders. The University supports its research students and requires participation in personal and professional development addressing Vitae's Researcher Development Framework. Core documentation includes the Postgraduate Skills Record, which records progress with the acquisition of research-specific and transferable skills and on programmes of related studies and relevant modules from taught masters' programmes. Participation in external, discipline-focussed postgraduate courses, attendance (and participation) at internal and external research conferences and seminars and training in specific approaches, techniques, etc., is encouraged and supported, partly via the University's active involvement in Vitae's North West Hub. An annual University research forum enables all research students, PDRAs, research staff and administrators to contribute, encouraging presentations and discussions on the national context, University policy and strategy, individual research projects, etc. Research student representatives are members of several University committees, helping to ensure that their views are heard; PRES (Post Graduate Research Experience Survey) is used to capture and respond to the student voice.

The PhD-by-Published-Works award was pioneered by IMRI specifically for senior managers in industry and commerce, enabling them to position work-based projects within an academic framework. Currently 7 students are enrolled from companies and organisations. Taught MSc courses encourage transfer to MPhil/PhD programmes (11 students transferred to date).

d. Income, infrastructure and facilities

The University provides a modern environment for the pursuance of world class research in these areas. The groups have a suite of advanced laboratories and workshops for conventional and novel material preparation/processing, including nano-, micro- and macro-composites and for testing small and medium-sized structures (impact and other physical/mechanical properties), plus a well-equipped fire research laboratory, which is unique within the UK. Since 2008 the University has invested 320K in a class 1000 clean room to accommodate advanced coating facilities for thin film materials and devices (magnetron co-sputtering, atomic layer deposition and evaporator). For thin film solar cells and smart devices through the KCMC project, the University has also invested in a new filament melt extruder (120K), an environmental SEM (108K), a high-performance computing server (100K), and an ALD (150K) and an Evaporator (50K). With industrial funding (£35K) the wet extruder has been upgraded to include a bi-component unit and an electrospinning unit has been built with full environmental control. The Renewable Energy group has also established a 100K optical/electrical laboratory from external and University funding. All equipment in the Fire lab has also been updated, partly by an EPSRC grant and partly funded by the University (200K). The unit has been funded through KCMC (£831K) and match funding by University (£800K) helping in infrastructure by the appointment of one reader (**Geng**), and one research fellow (**Soin**) and equipment worth £479K (see above). The University has also invested in a new automotive performance testing centre (£250K) which will benefit composites research.

Fire Materials (FM) research in textiles flammability area has been funded by US Army Research Office (Natick, 2009-2010: $50K) to improve the dispersion of nano/micro particulate flame retardants in polymers by ultrasonification of the polymer melt and by Defra (Department for Environment, Food and Rural Affairs, UK, 2009-2010: £21K) for a desk study providing a recommendation of the fire retardancy approach that has the best environmental performance for different key product groups (furnishings and bedding) across Europe. In structural composites by

EPSRC (2006-2009; £162K and 2010 – 2013: £427K to model fire damage in composite structures and co-blending of different resins for fire safe marine composites; TSB (2011-2014: £202K) for rendering natural fibre-reinforced, bio-composites flame retardant. Research in novel flame retardants is being funded by industry: William Blythe UK (EPSRC CASE: 2010 -2014; £89K) and Chemtura, US (2013-2015: $97K).
Within **Composite structures** research for Personnel Protective Equipment (PPE) has been supported by a CASE studentship (£77K, 2007-2009, EPSRC and Remploy UK), by Eastern Michigan University, USA (£42K, 2008-2010) for composites for body armour and armoured vehicles, by TechniTex/EPSRC(£76K, 2006-2009) for slash resistant vests, and by Remploy Frontline, and Future Textiles, UK ((£15K, 2010-2011). Recycling of carpet wastes in collaboration with University of Bradford was sponsored by Envirolink and university funding (2008-2012, 20K). Research into vehicle crashworthiness and related wheel chair and seat belt safety systems was supported by EU funding (FP6, 2007 – 2010, £24K).

Miraftab has developed two biomedical fibres working in collaboration with SEEDA/Sumed (2008-2013, £60K, EPSRC CASE Award £85K) and Xiros/TSB/Advanced Medical Solutions (AMS) (2009-2013, 11K), respectively. Both fibres are currently undergoing pilot production in China and UK respectively prior to commercialisation by the sponsoring companies. **Miraftab** is also the director and the UK sectional manager of a joint research consortium (Ireland, Israel and UK) supported by Marie Curie funding which involves the development of continuous cross-linked collagen fibres for tendon replacement/repairs (2010-2014, €250K). **Anand and Rajendran's** work includes sanitising workware/slash resistant fabrics in collaboration with ABurnet (2011-2012, KTP £81K), compression bandages in collaboration with Baltex Ltd (2009-2013, £30K) and pressure-relieving cushions for wheelchair users in collaboration with McArdle and Baltex (2009-2013, Vouchers £3K). **Shah** with The British Council/Pakistan Higher Education Commission Grant (£68k) developed smart/active filters for water purification. Bespak Limited, UK, supported (£50k) the work on EPDM Elastomer seals. H&R ChemPharm Limited funded (£12k) the development of a novel multifunctional layer acting as a waterproof membrane to replace the currently used geosynthetic clayliners.

Luo's work on SAW and FBAR sensors has been supported by EPSRC (2009-2012, £352K), one Leverhulme Trust Research grant (2009-2012, £97k) and one TSB and NWDA co-sponsored KTP project (2010-2012, £140k). His work on a world-leading ZnO thin film-based 'lab-on-chip' technology has attracted funding through Royal Society (International joint project with China, £11K 2010-2012) and Royce-Rolls (£16K, 2011-2012). His collaborative work in China has been funded by NSF, China (RMB 800K, 2010-2013) and Ministry of Science and Technology, China (one 863 project, RMB 2000K, 2010-2012).

In **RE group** the research in solar cells led by **Shao** attracted funding from TSB (£533K of the 933K total, 2008-2011), Joule Centre (2007 – 2009; 2010 - 2011: 90K, METRC (2010 – 2011: 6K) and industry (MBDA, 2011 – 2012: 16K). Shao has recently been awarded £180K TSB funded 2-year project with PQL on sustainable processing of energy materials (2014-2016), and 3-year EU project of £225K (2013 – 2016) on large-area organic solar cells. As international director of UK-China Centre for Multifunctional Nanomaterials at the Henan Province of China, **Shao** was lead scientist for NSFC (National Science Foundation of China) and MOST (Ministry of Science and Technology, China) funded projects of about RMB 2600K (2011 – 2015), provincial grant of about RMB 3000K and Chinese industrial sponsorship of about RMB 4000K.

All groups carry out consultancy, helping industry in developing their products, eg the Fire Group has done work for £125K over this period with William Blythe, ICL, MEL Chemicals and SAB Miller. **Miraftab** and **Anand's** other income generation activities are from conference organisations and consultancy for number of local and national companies including; Bolton General Hospital, Sumed International, Chembiotech, Scott Fyffe, Airbags International and TWI (Total income~£80K).

e. Collaboration and contribution to the discipline or research base

The **FM** group's work is often interdisciplinary and collaborative, hosting many visiting researchers, eg. Prof Dahiya from India funded by Commonwealth fellowship (2011), Dr J Alongi from Poltechico Torino, Italy funded by EU-COST (2013), Dr Abdallah from University of M'Sila, Algeria (2011), X.Wang from USTC, Hefei, China (Aug-Oct 2011), Erdoğan from Kahramanmaras University, Turkey (Aug-Nov 2011) and on average four undergraduate/post graduate students per year for 4 – 6 months from European counties (ENSICAEN Caen, Polytech Montpellier, ITECH Lyon, France) as internees, working on on-going research projects and adding value to the projects, while getting trained on research skills. FM's role in the SCI/FMDG and EU FLARETEX, (COST MP 1105, 2012-2016) has been described in Section (b) above. The EPSRC project (2010-2014) on fire retardant naval composites apart from academic partner (University of Southampton) has attracted collaborators from all sectors of the marine market – from materials suppliers (Scott Bader), ship builders (BVF) and boat yards (BVT) to operators (RNLI and MoD/Dstl/Royal Navy) and involves regulators (Lloyd's Register and MoD/Dstl) and statutory agencies (Maritime Coastguard Agency). The TSB project (2011-2014) on FR Bio-Composites has five industrial partners (NetComposites, Drake Extrusion Ltd, Tilsatec, Sam Weller & Sons Ltd, Exel Composites Ltd). The research findings apart from regular consortium meetings and scientific conferences, have also been presented in various workshops including Knowledge Transfer Networks. All group members are regularly invited for lectures nationally and internationally, **Kandola's** invited lectures include ISFRMT China (2010, 2012), COST Porto, Portugal (2008); COST Antalya, Turkey (2009); Espoo, Finland (2012), Institute of Nanotechnology, London UK (2009); NRC Cairo, Egypt (2010); Italian Association of Textile Industries, Milan, Italy (2012).
Kandola, Horrocks and Price have been referees for major fire science, polymers and composites journals. Kandola is Member EPSRC College (2003- present) and a Fellow (2006) and honorary representative of the Royal Society of Chemistry, University of Bolton. **Horrocks** continues to give plenary lectures based on his unique expertise in flame retardant textiles eg.the biennial European Flame Retardant Polymeric materials (FRPM) conferences, in 2009, 2011 and 2013 and to chair a small private company NWtexnet that assists UK textile companies with technology transfer and dissemination.

BMED group: **Miraftab** since 2008 has worked with Minho University, Portugal, Galway University, Rep. of Ireland and Ege University, Turkey, ENS Chimie de Lille, France as well as Jiaxing University, China and National Textile University, Pakistan. Nationally, Miraftab has been collaborating with Universities of Birmingham, Bradford and MMU. Industrial collaboration has included; Sumed International, Chembiotech, HIMedica, Speciality Fibres and Materials (SFM), Xiros, and Scott & Fyfe, Anglo Recycling and Eco2. He has co-chaired and co-organised three international conferences in textile recycling with Georgia Tech, USA and Kyoto University, Japan. Miraftab is on editorial board of Journal of Industrial Textiles. **Anand** was the Chairman of the Board and Council of The Textile Institute from May 2010 to April 2012 and was awarded the Companion of The Textile Institute in 2012, which is limited to 50 living members of The Textile Institute.

The **RE** group has a wide outreach in the renewable energy community: Member of the UK SuperSolar Hub (**Shao**), Founding Member of the IoM3 working group of Sustainable Materials in Emerging Energy Technology, SMEET (**Shao**), International Advisory Boards of the Asian Pacific Conferences of Environmentally Friendly Semiconducting Silicides and Related Materials since 2006 (**Shao**). Senior academics have also been conference chairs for international meetings on renewable energies: Materials for Renewable Energy (**Siores**, Athens, 2013), UK-China Symposium of New Energy Materials and Nanotechnology (**Shao**, 2012), keynote speakers on various internationals meetings (**Siores, Shao, Luo, Geng)**, guest editors (**Geng, Shao**) and editors (**Luo**) for international journals. **Luo** has organized many international meetings as conference (co)chairman. **Shao** is current Standing Panelist for the Physics Division of the Nationals Science Foundation of China (2012 --2014), Member and panelist of the EPSRC Reviewer College (2000 -) and panelist/reviewer for NSF Materials World Network and European and Japan research councils. Researchers are active referees to major international journals. For example, **Shao** has been active reviewer for leading internationals journals such as Nature, RSC journals, IOP/APS/AIP journals, acta Materialia.