Institution: University of Kent

Unit of Assessment: 8, Chemistry

a. Overview

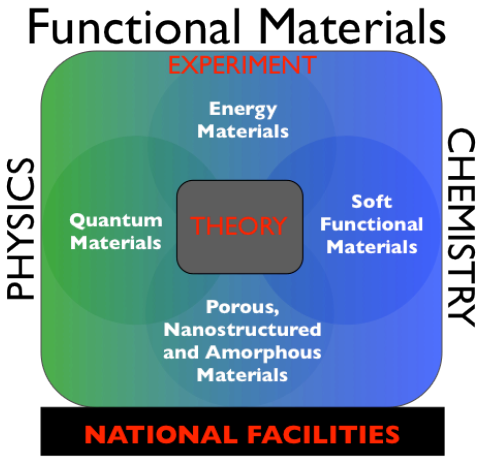
Four research groups operate within the School of Physical Sciences (SPS) at the University of Kent: Functional Materials (FMG), Centre for Astrophysics and Planetary Science, Forensic Science and Applied Optics. This submission describes the Functional Materials Group, an interdisciplinary research group across the Physical Sciences. Courses related to Chemistry and Physics (undergraduate and postgraduate) are taught across all four groups within the School, and this synergy and collaboration is also reflected in its research programme. The FMG has 17 members across the two disciplines, and utilises both experimental and computational/theory resources, underpinned by national facilities, such as neutron and synchrotron sources. It is divided into four themes (although many members hold interests across different themes):

Quantum Materials and Magnetism, such as New Magnets, Superconductors and Topological Insulators (13 members)

Energy Materials, such as Battery Materials and Solid Oxides Fuel Cells (8 members)

Soft Functional Materials, such as Porous Organic Materials, and Polymers (6 members)

Porous, Nanostructured and Amorphous Materials, such as Mesoporous and Self-Assembling Systems (3 members)



b. Research strategy

Evidence of achievement of strategic aim since RAE 2008

The University of Kent has operated a well respected materials research group for over 15 years. The group has been recognized for its internationally leading work in the study of novel materials, which has been focussed particularly on the understanding of structure and physical properties through both experiments and computer modelling techniques. In the 2008 Research Assessment Exercise, the group returned 6 members and obtained a grade point average of 3.05 from the Materials and Metallurgy panel, placing it equal second among UK universities. As a result, the University has made a strategic commitment to build upon the success and reputation of the group. Four strategic aims were defined in order to promote, and increase, the international quality of research within the Functional Materials Group:

1. Increase **staffing** levels across the group to ensure long-term sustainability and enable expansion into new areas of expertise (described in section **c**, sub-section **i**). Key staffing priorities have been to obtain critical mass; to balance individual teaching commitments within the School; to increase research productivity; and to enable FMG to be more competitive in Research Council funding calls. These goals have been achieved, with a growth of researcher numbers from 6 to 17.
2. Improve **infrastructure** through University investment, as well as competitive research grant bids to enhance the international quality of research equipment, and to diversify the Group's materials characterisation, synthesis and modelling capabilities. Since 2008 the University has invested £5.4M in equipment and facilities (section **d**).
3. Increase national and international **collaborations** to add value to the ongoing research programme, and enhance new ideas and methodology in Functional Materials. This has been achieved, and over the REF period FMG members have published more than 180 peer reviewed articles (section **e**) with international co-authors. The School has committed to SEPnet-2 and a research partnership with UCL.
4. Build upon the groups' strengths in the exploitation of **national facilities**, particularly synchrotron and neutron facilities, by developing and expanding collaborations with these facilities and achieving strong publication records. This has been successful and FMG staff have routinely won beam-time at the facilities at Diamond, ISIS, NIST and ESRF (section **e**).

Research strategy

The Functional Materials Group at the University of Kent has grown from 6 to 17 members since RAE 2008. It is an interdisciplinary group of research-active academic staff which harnesses experimental, computational and theoretical skills across the physical sciences. It aims to develop the synthesis, characterization and understanding of matter across a broad range of length scales from: atomic, molecular, nanomaterial, microporous and mesoporous materials to macroscopic phenomena. As part of the combined School of Physical Sciences its research and impact uniquely targets problems requiring synergistic research effort. The sustained increase in staff levels has allowed the group to develop four complementary research themes within its portfolio. These themes have been strategically chosen for their strong overlap and complementary techniques, so that the overall package is greater than the sum of its parts. Within that framework, most FMG researchers contribute to more than one of the four major themes (below) and a single theme can contain researchers with chemistry, physics or materials background, as well as have an experimental, computational or theoretical background. A summary of these new themes is given below:

Quantum Materials

Magnetism, Superconductivity, Multiferroics and Topological Insulators (**Arnold**, **Carr**, **Green**, **McCabe**, **Pugh**, **Quintanilla**, **Strange**), *X-ray and Neutron Scattering* (**Arnold**, **Alfredsson**, **Corrias**, **Green**, **McCabe**, **Mountjoy**, **Newport**, **Pugh**), *Quantum and atomistic modelling of clusters, nanomaterials, surfaces and interfaces* (**Alfredsson, Sayle**).

Soft Functional Materials

Functional porous organic materials (**Blight**, **Holder** and **Biagini**); *Gas absorption and carbon sequestration systems* (**Blight** and **Green**); *Synthesis of polymers, block copolymers and peptides* (**Biagini** and **Holder**); *Self-assembling systems* (**Biagini**, **Blight** and **Holder**); *Biomedical polymers* (**Biagini** and **Holder**); *Colloidal materials* (**Biagini**, **Holder**).

Porous, Nanostructured and Amorphous Materials

Functional nanomaterials, crystalline mesoporous materials metal organic frameworks and aerogels (**Blight**, **Corrias**, **Sayle**); *Catalytic materials* (**Corrias**, **Sayle**); *Nanomedicine (nanoparticle therapeutics)* (**Sayle**). *Glassy materials including oxides and hybrids* (**Mountjoy**, **Newport**).

Energy Materials

New battery materials including mesoporous oxides (Li-ion batteries), solid oxide fuel cells and polymeric materials (**Alfredsson**, **Arnold**, **Green**, **Holder**, **McCabe, Mountjoy**, **Sayle**)

The four themes straddle both Chemistry and Physics axis, with strong experimental work supported by complementary theoretical and computational work. These lie on a foundation of support and resources provided by the national facilities. The FMG's research strategy is implemented using the following SPS structure:

- **Research director.** Liaise between departments. Find and share best practice. Coordinate Heads of Group. Mentor and encourage.
- **Research committee.** Oversee plans. Coordinate. Monitor. Stimulate. Obtain support.
- **Academic** Conduct research. Develop plans. Disseminate knowledge. Train. Use support.

c. People, including:

i. Staffing strategy and staff development

The strategic investment by the University following RAE 2008 has been built on the existing strengths within the Functional Materials Group. In the 2008 RAE submission, the group comprised 6 members (Bruce, **Chadwick**, **Holder**, **Mountjoy**, **Newport** and **Strange**). Bruce, who has subsequently retired, was involved in experimental nanochemistry and some of his work is described in an impact case study (REF3b Nanoparticles for Biomedical Applications). In total 10 new members and 2 existing members of departmental staff have joined FMG since 2008. The section below describes how their expertise is reinforcing the existing strengths of FMG within each of the four themes:

Contribution of new staff to research themes

Our strategy across all of the research themes has been to utilise as wide a variety of approaches

as possible in developing and characterising new materials and for this reason each theme contains chemists, physicists and experimentalists, modellers and theoreticians.

***Quantum Materials and Magnetism*.** A major strength and strategic growth within the School is in the field of quantum materials and magnetism, particularly in superconductors, multiferroics, topological insulators and frustrated magnetic systems. Existing contributions were provided by **Mountjoy** on magnetic iron-containing nanoparticles and theoretical work by **Strange** on quantum theory of materials. This has been subsequently enhanced by **Arnold** who is involved in the synthesis of new multiferroic systems, and uses neutron scattering to accurately determine nuclear and magnetic structures. **Green** has worked on superconductors, charge ordered systems and the implementation of the new methods of analysing diffraction data. He has further worked on developing a new low temperature synthesis method to manipulate established structures to control their electronic properties. In his collaboration with the NIST Center for Neutron Research, he has also been involved with instrument development. **Pugh** has established a research programme in strongly correlated electronic systems, to establish how materials behave at ultra low temperature and extreme pressures. **McCabe** synthesises new oxychalcogenide systems, and is an expert in the determination of nuclear and magnetic structure. **Quintanilla** is a theorist involved in quantum condensed matter superconductivity and strong correlations, particularly topological superconductors. **Carr** is a newly appointed lecturer and works on the theory of related topological insulators. **Ramos** has worked extensively on oxides systems, and spent a number of years recently at the Diamond synchrotron source, and compliments the expertise in spectroscopy provided by **Chadwick**. This group now provides a coherent, cross-disciplinary and sustainable research base for quantum materials spanning the synthesis, characterisation and elucidation of their quantum phenomena and coupling experiment with computer modelling and theoretical exploration.

Energy Materials. The area of new battery materials is regarded as of central importance to the School and encompasses all aspects of battery material design including the synthesis and modelling of anode, cathode and electrolyte materials. Four of the new staff (**Arnold**, **Green**, **McCabe**, **Sayle**) directly contribute to this theme, complementing and expanding the expertise of **Alfreddson**, **Chadwick**, **Holder** and **Mountjoy** in this area.

Porous, Nanostructured and Amorphous Materials. Through the research of **Mountjoy** and **Newport** FMG has maintained a leading presence in the structural and chemical studies of glasses and amorphous materials including bioactive materials, through experiment and modelling. The theme has been expanded to encompass porous and nanostructured materials by three of the new staff members (**Blight**, **Corrias**, **Sayle**) contributing both modelling and experimental expertise. **Corrias** brings expertise in the synthesis and characterisation of oxide glasses, amorphous alloys, nanocrystalline alloys, and nanocomposites consisting of metal or metal oxide nanoparticles embedded in a silica matrix. **Blight** synthesises and characterises new metal organic frameworks and **Sayle** is a computational modeller with considerable experience of modelling the structure and chemical activity of nanostructured materials and nanoparticles.

***Soft Functional Materials*. Biagini** has expanded the research that **Holder** is undertaking in macromolecular systems, such as polymers, peptide, and self-assembly systems, with **Blight** adding new directions in supramolecular chemistry and microporous metal organic framework materials (MOFs).

The successful development and exploitation of national/international synchrotron X-ray and neutron scattering facilities (**Chadwick**, **Mountjoy, Newport**) has been a world-class strength for FMG. Expertise in this area of materials study has been dramatically enhanced further by the appointments of **Arnold**, **Corrias**, **Green**, **McCabe** and **Ramos**. **Quintanilla** was appointed Lecturer/SEPnet Fellow in Condensed Matter jointly between Kent and the STFC Rutherford Appleton Laboratory (RAL).

Career development (all staff)

The career development of new academic staff is supported by the University's Postgraduate Certificate in Higher Education (including research planning and management and PG supervision) and by the early career researcher network, which provides a forum for training targeted at those starting their first academic position. In addition, newly appointed lecturers are mentored by an experienced, research-active, staff member and are given a 3-year probation which includes reduced teaching and administration workloads (typically 1/3 of normal load for the first year and

2/3 for years 2 and 3 following appointment) to support them in setting up their research groups and developing as independent researchers. Staff development courses in transferable/generic skills are run by the University and all academics and PDRAs are required to attend at least one a year. PDRAs enjoy full access to the wide range of staff development courses offered by the University.

Research success is acknowledged and promoted by allocating time within workload schedules to grant preparation, management, the supervision of PGs and PDRAs, and for the dissemination of results. Reduced teaching and/or administration workloads are also given as a result of research success. The University encourages and supports staff development through sabbaticals (typically 1 year study leave for 7 years' service).

The University of Kent is fully engaged with the Concordat to support researcher development and the key principles are embedded in our approach to staff. As part of this the University attained the European Commission's HR Excellence in Research Award in 2013.

Equality and diversity

SPS is dedicated to equality opportunities and diversity. Both the School and the University are committed to the principles of the Athena SWAN Charter and the University has submitted its application for a bronze University-level award. Over 35% of FMG researchers being submitted and over 50% of FMG appointees since 2008, are women. Building on this we have created a working group which has already begun the work to enable an Athena SWAN School award submission to follow success at University level. The School is also committed to the Institute of Physics Juno project. The School boasts both a dedicated Athena SWAN committee which receives support from a part-time administrator and a department equal opportunities representative and harassment officer to ensure best practice and identify potential weaknesses for change. Furthermore SPS is part of the HEFCE-funded South East Physics Network (SEPnet) which as part of SEPnet-2 has funds available to members for Athena SWAN events. SPS has an excellent track record of equality and diversity with an active staff body reflecting this. There is much support on campus such as through the Women's Network, early career researcher support, research funding support as well as diversity awareness workshops/open days. SPS actively promotes diversity by not only following appropriate University recruitment policy (at all levels) but also by considering appropriate diversity in, for example, in-house seminar series and invited talks.

ii. Research students

Recruitment approaches

In addition to EPSRC DTA and Industrial CASE awards and self-funded studentships, FMG actively applies for PhD studentship grants via the ALIStore network (3 PhD studentships since 2008) and from SEPnet (3 PhD studentships since 2008). Additionally in 2009 the University instigated the funding of studentships across the University which has expanded (since 2012) from 1 a year per department to 3 a year per department. FMG has been the main beneficiary of this scheme within SPS with 7 University PG scholarships in FMG since 2008. The total FTE postgraduate research students enrolled on doctoral programmes (supervised by a member of FMG) per academic year of the assessment period are given below along with the figures for the current year.

	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
FTE	13	14.5	14.5	20.5	21.5	26.5

Training quality, support and progress

The University of Kent Graduate School (including student representatives) organizes postgraduate (PG) training in conjunction with the Schools and coordinates the transferable skills training programme for PG students. It services the Graduate School Board, Transferable Skills Training Operational Group and Directors of Graduate Studies' Network Group. The Graduate School aims to provide a clear institutional focus on the development and support of graduate education and research at Kent. It coordinates the Researcher Development Programme for PG and postdoctoral (PD) researchers. The Programme is designed to equip PG and PD researchers with a full range of skills which will improve their effectiveness as researchers, and ensure that they are not only highly qualified but employable in a variety of careers by the end of their research

projects.

Since 2009/10, all PGs registered on a PhD programme are required to complete a skills audit by the end of their first year of registration. Attendance at a minimum of 10 days of Skills Training per academic year is mandatory for PGs. Successful completion of skills training to a defined threshold became compulsory for all first-years starting a PhD at the University of Kent after September 2009, and meeting these thresholds has been a condition of the probation review from September 2011.

Within SPS a taught module must be attended and the exam passed or a distinct extended Literature Review submitted to accompany the 9-month report. PGs are required to attend all colloquia arranged by FMG. An internal school PG conference is held each academic year where 3rd years present conference-level talks and 1st and 2nd years present and defend posters. Feedback is provided to the participants by the attending academics and students. PGs must attend at least one national and/or international conference and make a presentation. The School subsidises conference attendance where immediate funding is not sufficient. All PG students must give an oral presentation to the whole of FMG during their research period. A list of training milestones is presented below:

Milestone	Month	Report/Task	Milestone	Month	Report/Task
M1	1	Induction Review	M10	24	Review End Yr2
M2	8	Probation Review	M11	24	Annual Report Yr2
M3	8	Taught Module or Literature Review	M12	24	Progress Report Yr2
M4	12	Review End Yr1	M13	24	Skills Audit Yr2
M5	10	Annual Report Yr1	M14	25	PG Symposium (oral)
M6	12	Progress Report Yr1	M extra	30	Mid-year review
M7	12	Skills Audit Yr1	M15	33	Submission Review
M8	12	Colloquium check	M16	36	Skills Audit Yr3
M9	13	PG Symposium (poster)	M17	36+	Thesis Submission

d. Income, infrastructure and facilities (30%)

Infrastructure and investment

There have been significant improvements in the research environment for FMG following the group's success in RAE2008. Since 2008 the University has invested circa £1.1M in new research-level equipment, spanning synthesis and characterisation, including a computer cluster, scanning electron microscope, 400 MHz NMR spectrometer, Raman spectrometer/microscope, X-ray fluorescent spectrometer, powder X-ray diffractometer, FT-IR spectrometer, SEC/GPC system, nitrogen adsorption system, ball-milling instrument, glove box and numerous smaller items of laboratory equipment. In addition to the new equipment, FMG has a further range of existing in-house instrumentation employed for materials preparation, analysis and modelling including, two further X-ray diffractometers, two DSCs, TGA, two SEC/GPC systems, a particle sizer, Raman, FT-IR and polarising optical microscopes, ATR, UV-vis, ovens/furnaces up to 1800°C and including gas flow/vacuum options, substantial computing facilities, a 200kN temperature controlled (300°C) sample press, a Nano-Zetasizer and various centrifuges. Within the wider Sciences Faculty at Kent FMG has access to TEM (including cryo-TEM), AFM, and MALDI-TOF. All PGs and PDRAs within FMG have access to and the use of the group's research equipment subject to appropriate training.

Since 2008 the University has also invested circa £4.3M in the refurbishment of SPS including teaching and research labs and new staff offices.

Research in SPS is supported by a pool of 13 experimental officers and technicians. All permanent faculty members have their own office and there are separate rooms for RAs and PGs (outside of labs). Monthly FMG colloquia bring internal and external researchers to the groups. Centrally, the University provides a Research Office offering assistance and peer-review of grant applications, a well-stocked library with a specialist science librarian and extensive electronic access to major journals (additionally there is a £230,553 *pa* departmental budget contribution for subject-specific library material).

Sustainability

To increase the financial leverage and reach of the FMG and thereby enhance sustainability, our research strategy has been to develop collaborative ventures Together with our enhanced staffing – in particular the 4 ECRs appointed since 2012 – this ensures the long-term sustainability of the Group's research. Examples include SEPnet, ALISTORE, DSTL and a memorandum of understanding with UCL (described below). Sustainability is also maintained by heavy involvement with the exploitation and development of national and international facilities, including synchrotron X-ray and neutron scattering facilities (**Arnold**, **Corrias**, **Green**, **Mountjoy**, **Newport**), which adds world-class strengths to our portfolio.

A consortium of 7 regional university departments (Kent, Portsmouth, QMUL, RHUL, Southampton, Surrey & Sussex) form the **South-East Physics Network (SEPnet)** and were awarded £12.5M from the HEFCE strategic development fund in 2008. This network was formed to enhance the sustainability of Physics in SE England through strengthening research collaborations and promoting the subject through outreach and employer-engagement. One major SEPnet theme is condensed matter theory which, through the appointment of **Quintanilla** as Lecturer/SEPnet Fellow, jointly at Kent and at the STFC Rutherford Appleton Laboratory (RAL), enhanced materials research at Kent and promoted and consolidated already existing ties with RAL. **Quintanilla** is the current chair of SEPnet's Atomic and Condensed Matter research theme. The new **SEPnet-2** (2013-2018) consortium was awarded £2.75M from the HEFCE Catalyst Fund. It consists of nine core universities (Open University and Hertfordshire joining). Funding will be invested in an innovative Graduate School and enhanced Outreach and Employability programmes, with the consortia contributing £10M. FMG research will also benefit from SEPnet-2 through funds to promote research collaborations.

The School's strategic partnership with **DSTL Materials and Structures Science and Technology Centre** (MAST-STC) was approved (by DSTL) in March 2012. A number of FMG academics are included (**Alfredsson**, **Arnold, Holder**, **Mountjoy**). This arrangement allows SPS to bid for project work as described in periodic calls by DSTL. Regular meetings have already commenced between Kent Innovation and Enterprise representatives and FMG members to explore and discuss recent funding calls and these will be ongoing events. An immediate consequence of the MAST-STC partnership has been the allocation of an industrial Case studentship from DSTL with **Alfredsson** (on new battery technologies) and a joint submission from **Holder** with the School of Engineering and Digital Arts (Kent) for CDE funding (on materials for RFID sensors).

ALISTORE began in 2004 as an EU Network of Excellence aimed at developing advanced lithium ion batteries and is now an ERI (European Research Institute). It consists of some 20 leading laboratories (both academic and industrial) across Europe working on lithium ion batteries. SPS has been a member from the original planning stages. It provides Kent with contact with all the latest developments in the battery field through regular meetings and discussions. In addition to the intellectual benefits it funds PhD students and PDRAs. Kent has been funded for three PG students (co-tutelle) and a PDRA. The special role of Kent in ALISTORE is to manage the X-ray Absorption Spectroscopy platform and is a major contributor to the theory platform. All staff members of SPS are theoretically members of ALISTORE as it is a contractual agreement between laboratories and not individuals. The key members in the past have been **Alfredsson**, **Chadwick**, and **Mountjoy,** but membership has been expanded to include **Arnold**, **Holder** and **Sayle**.

Within a memorandum of understanding (starting 2012), **University College London** and the University of Kent are committed to share research equipment, research students and teaching resources. As a project partner, the University of Kent is involved with an expansion of research equipment at UCL, where 25% of the capacity of the equipment is designated to outside users. The three-year program, includes £1.5m of new equipment and upgrades including state-of-the-art powder XRD, single crystal XRD, thin film XRD, mass spectrometry and AFM instruments.

Consultancies/professional services

Consultancy services are offered to industry and make use of the School's Analytical Suite, a new facility opened in September 2012. The Suite includes FTIR, HPLC, NMR, Raman, SEC and SEM.

The consultancy service also involves the expertise of its Experimental Officers and the research

expertise, experience and knowledge of its academic staff. The service was launched at the Business Growth through Innovation SME event on 19 June 2012, organised jointly by KIE and Kent Invicta Chamber of Commerce. It brings collaborative, financial and entrepreneurial skills to FMG, as well as enhancing the presence and visibility of the Group. During the REF period contracts have been completed with companies including Alchimica Chemicals (Greece), Cadburys (UK), Kraft Foods (USA), Megger Instruments (UK).

e. Collaboration or contribution to the discipline or research base

Collaborations

Since 2008 the members of FMG have published 321 articles in peer reviewed journals which have gathered >4000 citations; our collaborative ethos has resulted in 180 articles with international co-authors and more than *half* of the peer-reviewed publications submitted in REF2 having 1 or more international co-authors.

Our collaborative work spans 6 continents and key examples of national and international collaborations are given below:

Materials modelling is a key technique employed within FMG. **Sayle** is part of an ongoing collaboration with researchers at the College of Medicine University of Central Florida investigating the toxicity of nanomaterials with direct application in nanotherapeutics. The modelling and simulation of the activity of ceria nanomaterials in combination with in-vivo and in-vitro experiments at Florida, has helped to explain why the nanoparticles display therapeutic or conversely toxic effects in therapeutic applications. This collaboration is an excellent example of the modelling combined with experimental approach being supported and promoted within FMG and in this case is leading to the faster screening of nanomaterials for potential future therapeutic applications. (**Sayle, Outputs 1,2**)

For the last eight years there has been a close collaboration with conservators at the Mary Rose Trust in studying the 'sulfur problem' in archaeological timbers (**Chadwick**, **Newport**). SPS provided the expertise in X-ray absorption spectroscopy as this technique provides a unique way to study sulfur speciation. The collaboration provided funding for a PDRA and led directly to the development of a nano-particle remediation method for the de-acidification of the Mary-Rose timbers and is now being further utilised in the preservation of other heritage artefacts. The work is on-going with a long-term project at Diamond (Prof Fred Mosselmans) to monitor sulfur speciation for the next decade in the Mary Rose timbers (see REF3b Mary Rose impact case study).

Originating as a collaboration between Kent (**Newport**) and the NMR group at Warwick in the 90s, an active and on-going partnership in the study of sol-gel and other glassy materials has emerged which now also encompasses Imperial College, UCL, Lancaster and Aston. The range of materials studied is broad, but there is a distinct focus on bioactive materials for tissue regeneration and drug delivery. The partnership enables synthesis development and the application of a suite of advanced probe methods, together with computer simulation (**Mountjoy**), in the context of biomedical materials research. The Kent team (**Newport**), who focus on synthesis and structural characterisation (including the use of STFC-managed facilities), have benefited from a total of ~£1.8M in research awards during the this partnership (~£770k of active awards in the REF period) and its work has contributed to over 90 journal papers (40 in the REF period). (**Newport, Outputs 1 to 4**)

Each of the research themes benefits from the use of advanced characterization techniques facilitated by national/international laboratories, particularly at neutron and synchrotron radiation facilities across Europe, North America and Asia and FMG staff have routinely won beam-time at the facilities at RAL, Diamond, ISIS, NIST and ESRF.

Other international collaborations and partnerships resulting in peer-reviewed articles with FMG researchers include:

Europe *Austria* (Austrian Acad. Sci.), *France* (Univ. Clermont, Univ. Nantes, CNRS Aubières), *Cyprus* (Univ. Cyprus), *Germany* (Univ. Marburg, Univ. Munich, Karlsruher Inst Technol., Max Planck Inst. Dresden), *Italy* (Univ. Cagliari, Univ. Turin, Univ. Florence, Univ. Verona), *Netherlands* (Eindhoven Univ. Technol., Univ. Delft), *Spain* (Univ. Cordoba, Inst. Catala Nanotecnol). **Asia** *China* (Hong Kong Inst. Educ *Japan* (Japan Agency Marine Earth Sci. & Technol.). **North America** *Canada* (Univ. Western Ontario, Univ. Windsor), *USA* (St Olaf Coll., Univ. Florida, Ctr. Interdisciplinary Magnet Resonance, Prairie View A&M Univ., Virginia Tech.). **South America**

Brazil (Univ. Fed Sao Carlo, Univ. Sao Paulo). **Africa** South Africa (Univ. Limpopo). **Australasia** *Australia* (Univ. Queensland), *New Zealand* (Univ. Canterbury).

Nationally, FMG staff have collaborated with researchers at a range of universities including Bath, Birmingham, Bristol, Cambridge, Dundee, Huddersfield, Kings College, Imperial College, Manchester, Queen Mary College, Sheffield, St Andrews, University College and Warwick. Further collaborations resulting in peer-reviewed publications are ongoing with researchers at the Rutherford Appleton and Daresbury Labs.

We work directly, through research funding, enterprise contracts and CASE studentships, with a range of end-users of materials which have been synthesised, characterised or modelled by members of FMG. These include St Bartholomew's Hospital (London), St Thomas Hospital (London), the Natural History Museum (London), The Mary Rose Trust (Portsmouth), AWE (Reading), Novamin Technology Inc. (USA), Megger (Kent), Kraft Foods (USA), Cadburys (Reading) and Merck Chemicals (Southampton). For further information on our non-HE collaborations and partnerships please see REF3a.

Committee and panel memberships

Management Advisory Panel - EPSRC UK National Service for Computational Chemistry Software (**Alfredsson**). Chair of Solid State and Materials Chemistry subdivision of the Division of Inorganic Chemistry, American Chemical Society (**Green**). Member of ESPRC Physical Sciences Materials Panel (May 2010) and EPSRC CDT Interview Panel (October 2013) (**Holder**). Chair of STFC Physical and Life Sciences Committee, member of STFC Science Board and STFC Large Facilities Science Group, member of Diamond Light Source (DLS) Science Advisory Committee, Chair of DLS International Review Panel for Beamline B18 (**Newport**). Member of Royal Society Equality and Diversity Advisory Network Panel (**Pugh**). Chair, Atomic and Condensed Matter Research Theme, SEPnet (2010-2012) (**Quintanilla**). Member of ESRF Xmas Beamline Peer Review Panel, Chair of ESRF Peer Review Panel on Hard Electronic and Magnetic Materials (**Strange**).

Examinations and reviewing activities

6 EPSRC College members (**Alfredsson**, **Chadwick**, **Green**, **Holder**, **Newport**, **Strange**). 30 national and international doctoral examinations over REF period (**Alfredsson**, **Chadwick**, **Mountjoy**, **Newport**, **Pugh**, **Sayle**, **Strange**). All members of FMG are active in refereeing journal articles on a regular basis including Nature, ACS, RSC, IoP, Wiley and Elsevier journals.

Conference organisation

Alistore-ERI (Kent, 2010), Structure and Dynamics in the Solid State (Kent, 2010) and CCP5 (Kent, 2013) (**Alfredsson**). 2nd Central and Eastern European Conference on Thermal Analysis and Calorimetry (Lithuania, 2013) (**Arnold**). Condensed Matter in the City (London, 2013) (**Carr**).International Conference Series Lattice Defects in Insulating Materials (Hungary, 2012) (**Chadwick**). Convegno Materiali Nanofasici (Nanophase Materials Meeting) (Italy, 2009) (**Corrias**). American Conference on Neutron Scattering (USA, 2012), International Materials Research Society (Mexico, 2103), Chair Solid State Symposia - American Chemical Society Meetings (USA, Spring & Fall 2012 to 2013 (**Green**). International Strongly Correlated Electron Systems Conference (Cambridge, 2011) (**Pugh**). SEPnet IV, III, II and I Summer Programmes "Condensed Matter Physics in the City" (London, 2010, 2011, 2012, 2013), Advanced Working Group on Nonequilibrium Phenomena in low-dimensional Cold Gases (Egham, 2012), 3rd British-German "Frontiers of Science Symposium" - Royal Society, (Royal Society Kavli Centre, 2011), Advanced Working Group on Experimental Probes of Topological Matter (2011, Egham). Strong Correlations Symposium, CMMP'09 (Warwick, 2009), Condensed Matter/Quantum Information/Cold Atoms Interface European Meeting (Abingdon, 2009) (**Quintanilla**). EXAFS Data Analysis Training Course (Diamond Light Source, 2012) (**Ramos**).

Invited Lectures and Presentations

Members of FMG have given over 75 invited presentations at national and international conferences, workshops and seminars during the REF period including international talks in Austria, Canada, France, Germany, India, Japan, Korea, Mexico, Netherlands, New Zealand, Russia, Spain, Sweden, Taiwan, Turkey and the USA.