

## Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Materials Science and Engineering and Nanotechnology

### Panel Members

Ravi Silva (Chair)	University of Surrey, United Kingdom
Arben Merkoci	Universitat Autònoma de Barcelona, Spain
Fabiola Vilaseca Morera	Universitat de Girona, Spain
Jean-François Gerard	Institut National des Sciences Appliquées de Lyon, France
Justin Holmes	University College Cork, Ireland

### R&D Units

Centro de Ciência e Tecnologia Têxtil (2C2T)	Universidade do Minho (UM)
CICECO - Instituto de Materiais de Aveiro (CICECO)	Universidade de Aveiro (UA)
INESC Microsistemas e Nanotecnologias - Instituto de Engenharia de Sistemas e Computadores para os Microsistemas e as Nanotecnologias (INESC-MN)	Instituto de Engenharia de Sistemas e Computadores - Microsistemas e Nanotecnologias (INESC MN/INESC/IST/ULisboa)
Instituto de Nanoestruturas, Nanomodelação e Nanofabricação (I3N)	NOVA.ID.FCT - Associação para a Inovação e Desenvolvimento da FCT (NOVA.ID.FCT/FCTUNL/UNL)
Instituto de Polímeros e Compósitos (IPC)	Universidade do Minho (UM)
Materiais Fibrosos e Tecnologias Ambientais (FibEnTech)	Universidade da Beira Interior (UBI)



## Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Materials Science and Engineering and Nanotechnology

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**R&D Unit:** Centro de Ciência e Tecnologia Têxtil (2C2T)

**Coordinator:** Fernando Batista Nunes Ferreira

**Integrated PhD Researchers:** 26

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**Overall Quality Grade:** VERY GOOD (\*)

### Evaluation Criteria Ratings

(A) Quality, merit, relevance and internationalization of the

R&D activities of the Integrated Researchers in the R&D Unit Application: 4 (\*)

(B) Merit of the team of Integrated Researchers: 4 (\*)

(C) Appropriateness of objectives, strategy, plan of activities and organization: 2

**Base Funding for (2020-2023):** 390 K€ (\*)

### Recommended Programmatic Support

PhD Fellowships: 4

Programmatic Funding: 235 K€, including for 1 (Junior) New PhD Researcher Contract.

(\*) After Preliminary Hearing

### Justification, Comments and Recommendations

The Centre for Textile Science and Technology (2C2T) is a R&D Unit builds on roots that extend back to 1978 in the area of Fibrous Materials Engineering and Design. Its vision is to contribute to the global competition that currently exists in building the supply chain components for the textile industry, thus contributing much to societal impact. The three strategic goals of Scientific and technological leadership, Excellent education and Strong partnership (local, regional and EU) highlight the direction of travel of the organisation; with clear routes for societal impact. 98 funded projects have been identified, with 178 journal papers, and an increasing funding profile from 2013-2017. Yet the industry income and external visibility is limited, but, on an upward trajectory.

On the basis of the submitted application and the site visit, the Centre got an evaluation of Good derived from the following observations:

The Unit, established in 1978, consists of 27 Integrated Researchers which had a good publication over the review period, including 176 papers in journals, 71 book chapters and 352 conference papers. The dissemination of results through conference papers is double that of journal articles, which while this may reflect the research disciplines, may lessen the wider impact of the interesting research going on within the research groups. Of the nuclear CVs listed, on 3 out of 26/27 researchers. The Unit has run 98 funded projects (85% financed by contracts with the National Innovation Agency (ANI) or other governmental sources, 10% by the Portuguese Foundation for Science and Technology (FCT) and the remaining 5% by European programmes); 100 funded projects carried out (3.6/researcher). The integrated researchers have filed 20 patents over the review period which is a good achievement.

The Integrated Researchers make significant contributions to training of PhD and MSc students. Additionally, of significant note is the contribution researchers make towards short courses for researchers and industry, which is a great initiative for further developing collaborations with industry partners. Researchers have also been involved in 'science and innovation fairs' which involves dissemination to a public audience. However, outreach to school children, such as class visits etc., was not mentioned in the application.

Of the 5 contributions the Unit considers most important, whilst these clearly demonstrate the expertise of the Integrated Researchers of the Unit, overall the impact of the 5 achievements, in relation to state-of-the-art and real/measurable economic and social impacts were not clearly defined. For example, the commercial feasibility of the fibre-based sensors is clear but what was unclear in the application was if the technology was developed with an industry partner and how the development compares to state-of-the-art in the field.

The research in micro and nanomaterials has resulted in the formation of a spin-off company (Micropolis). It is an interesting use of a biopolymer, such as chitosan, instead of chemical pigments. A clearer idea of state-of-the-art in the

field would have helped put the research into context. The engineered of textile structures was identified as being significant to the Centre in terms of science and promoting knowledge transfer, but unclear from reading section 4.1 what the impacts of this research have been to date.

One can mention the interesting and relevant researches on engineered braided structures integrating biodegradable and non-biodegradable fibres functionalized with silver nanoparticles for antibacterial properties and on a brain phantom based on hollow polypropylene fibrous arrangements and innovative research done on negative Poisson' ratio composite materials.

Quite few funds are coming from the European Commission, i.e. 5% which could emphasize the fact that the 2C2T Unit is not enough proactive within the European calls.

The selected realizations demonstrate that the relevant character of the researches done at 2C2T for the textile industries. The reported contributions of 2C2T in this area are driven by technological attempts and only few of them led to identify scientific questions to be solved, i.e. to position 2C2T on very fundamental problems.

The transfer of the researches by the creation of spin-off companies of the 2C2T remains limited in the past period.

The Unit brings together researchers with a range of expertise in 2 main groups. There is evidence from joint publications that the researchers collaborate together and the Unit is looking to develop synergies between the 2 research groups within the Unit over the next 5 years. There is also an increased drive by the Unit to increase the number of projects each researcher is involved with by 10 %.

The Unit and team of Integrated Researchers certainly have a presence in Portugal and are recognised internationally. This is evident from the interaction of team members with researchers from 3 European research institutes and a non-European institute, established as part of a network in the area of smart and multifunctional fibre materials systems established by the Unit in 2015. The Unit should leverage such interactions to strengthen attract more EU funding into the Unit. Additionally, the Unit attracts non-EU students, Brazilian, students into its doctoral programmes, which is an excellent selling point for the Unit and could potentially be expanded to attract students from other South American countries. The Unit needs to understand what attracts these students to the Centre. How many students come from Brazil each year and is there room for expansion? Can targets be set for the Unit? The team should be commended on their postgraduate a professional training. The Unit intends to further develop international joint postgraduate programs, but it was unclear from the documentation how this will be enacted.

Whilst the team intends to further promote 'interaction design methodologies' to generate competitive products, as part of its planned activities for the next 5 year, it is unclear to what extent.

The research activity plan for the Unit is clear and described in detail, however how this research relates to state-of-the-art and what is going on in other worldwide research groups is not clear. The Unit needs to set better targets in its strategy, e.g. what are the EU funding targets, how many and which new companies will be targeted by the Centre, how many and with whom will international joint postgraduate programmes be developed. There is a lack of quantification of targets in the over strategy proposed by the Unit.

The strategy proposed for the next 5 years appears to follow very much the strategy developed for the previous 5 years, but this lacks creativity. Also, this means that new opportunities, and competitors, for the Centre have not been identified. There should be at least 1 new area for development over the next 5 years.

The Unit has done well over the review period organising scientific/technical meetings geared at both academics and industry. The Unit intends to continue its work to develop further training activities with companies. A possibility is to have 'industry days' to find out the issues/requirements of relevant national industries – particularly around sustainability, which could lead to the formation of consortia.

The structure/organisation of the Unit is clearly defined in the application, particularly in relation to managing scientific or organisational issues. The regular assessment of research projects by team members is a good initiative. However, are projects ever cut or extended based on these reviews? Some aspects of management structure in the Unit does appear cumbersome, such as the Scientific Commission – which will consist of 27+ people, which must make decision making difficult.

One can recommend to identify clearly basic scientific questions from the attempts from the textile industry but also to develop basic researches, i.e. having a very low level of TRL, for offering future rupture solutions.

The R&D Unit needs to be more proactive in applying to European projects in order to have a significant part of its funding coming from European Commission. In addition, these applications will strengthen the collaborations with partners out of Portugal and the internationalization of the 2C2T activities. The initiative of creating a special office dedicated to improving the European involvements is strongly supported.

The project claims that the target is to have 2 papers/year/researcher. This remains poorly ambitious both in terms of volume and quality which needs to be improved. The Unit needs to strengthen its efforts on the internationalization of its researchers via different tools: international seminars and conferences as already mentioned, Master and PhD courses opened to students from abroad. The 2C2T Unit is invited to applied to European calls such as the ones dedicated to Marie Curie grants and sites.

## Evaluation Panel: **ENGINEERING SCIENCES AND TECHNOLOGIES - Materials Science and Engineering and Nanotechnology**

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**R&D Unit:** CICECO-Instituto de Materiais de Aveiro (CICECO)

**Coordinator:** João Carlos Matias Celestino Gomes da Rocha

**Integrated PhD Researchers:** 183

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**Overall Quality Grade:** EXCELLENT

### Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
- (B) Merit of the team of Integrated Researchers: 5
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 5

**Base Funding for (2020-2023):** 3312 K€

### Recommended Programmatic Support

PhD Fellowships: 12

Programmatic Funding: 1075 K€, including for 3 (2 Junior, 1 Assistant) New PhD Researchers Contracts.

### Justification, Comments and Recommendations

The researchers within CICECO-Aveiro have filed numerous patents and published a large number of research articles over the review period. Most of these articles were published in internationally recognised journals, receiving a good number of citations over a short time period. Additionally, over the review period researchers produced prototypes and generated spin-out companies. The Centre was able to attract considerable research income from industry and EU programs, including ERC awards and the researchers were involved in several EU training programmes, including Erasmus Mundus and Marie-Curie. Researchers within the Centre organised international conferences and participated in numerous outreach activities, such as school visits, the organisation of National Chemistry Olympiads, as well as citizen science events, including science-art debates and demonstrations. In relation to the five highlighted contributions to the Centre, the researchers raised considerable funding from research projects and industry interactions, including from partnerships with national and international companies. CICECO-Aveiro have excellent lab facilities, being awarded a number of infrastructure/equipment grants.

The Centre has world-wide recognition, attracting international researchers and with many of their publications being co-authored with foreign institutions over the review period. The expansion and diversification of the research staff within the CICECO-Aveiro over the last five years has been impressive. The structure of the Centre is built around fostering collaboration, with six research groups and four cross-cutting research lines. There is evidence from research publications that these groups work together closely through the thematic research lines. There have been several impressive impacts from the researchers within their distinctive groups, such as (i) the use of textile electronics in preventative health and sustainable manufacturing, (ii) the development of novel magnetic computational tools, (iii) joint projects with National and European industry, including smart healing coatings for corrosion protection of metallic substrates, (iv) the creation of a phthalate-free plasticisers from vegetable oils and (v) modelling of halogen-bond and chalcogen-based bond systems.

The future strategy of CICECO-Aveiro is to build upon its present activities but also to initiate new research areas, such as in responsive materials. Societal challenges in areas such as sustainability, energy and health will also be tackled, which are important for the future expansion of the Centre. The management structure of the Centre, embedded within the University of Aveiro, appears to be appropriate for the size of the Unit and includes a Scientific Council, a Directing Board and an External Advisory Board, composed of four international scientists. However, the review panel recommends that the membership of the External Advisory Board be expanded to include experts that can fully cover the broad range of research activities within the Centre. CICECO-Aveiro's strategic vision over the next five years was clear, including plans to initiate new research areas, increase the number of European awards, grow the National and International student and researcher base within the Centre, as well as creating CICECO-industry partnerships and collaborative laboratories. Outreach activities continue to form an important part of the Centre's strategy, with the ambitious plan to create a European network of schools, universities, R&D Centres and companies to raise awareness of materials science. The Centre also plans to co-ordinate a number of national and international workshops and conferences over the next five years.

A compelling case was put forward by CICECO-Aveiro for funding new areas and programmatic grants going forward. Of note, the contracts of many researchers within the Centre will come to an end over the next year, so it is crucial for the Centre to attract new research funding to retain excellent staff. Given the size of the research activity within the Centre, from the documentation provided and the site visit, it was still unclear to the review panel how the funding provided by FCT would be utilised, but it was clear that any resource provided in this call would be put to very good use and result in high quality and highly visible outputs.

The review panel felt that the particular strengths of CICECO-Aveiro included: (i) enthusiastic and engaged research staff and students, (ii) the multidisciplinary nature of the organisation, with well organised, large research groups having real focus, (iii) good communication and interaction between research groups, (iv) evidence of the clear impact of the research going on with the Centre, both basic and applied research, (v) highly competitive in attracting EU funding to support both basic and applied research, (vi) excellent industry links and commercialisation strategies, including technology transfer and (vii) outstanding research facilities.

Recommendations of the Evaluation Panel include:

- (i) Expand the membership of the External Advisory Board to include international researchers that can fully cover the broad range of research activities within the Centre.
- (ii) Improve representation of junior researchers and postgraduate students within the management structure of the Centre, so that they can be fully engaged and have a collective voice in the decision-making processes within the Centre. This could include having student and junior representation on Centre committees.
- (iii) Establish career development plans for junior researchers within the Centre, which will help them to transition to either senior researchers or move into industry. The junior researchers would also benefit from many of the personal training programmes provided by the University.
- (iv) Promote better unity between the postgraduate students, possibly through an annual 'Student Research Day' where all postgraduate students within the Centre come together to give poster and oral presentations on their research.
- (v) The University should provide additional space for the Centre to expand. In the short term, staff and students offices/desks should be removed from research laboratories.

## Evaluation Panel: **ENGINEERING SCIENCES AND TECHNOLOGIES - Materials Science and Engineering and Nanotechnology**

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**R&D Unit:** INESC Microsistemas e Nanotecnologias - Instituto de Engenharia de Sistemas e Computadores para os Microsistemas e as Nanotecnologias (INESC-MN)

**Coordinator:** João Pedro Estrela Rodrigues Conde

**Integrated PhD Researchers:** 14

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**Overall Quality Grade:** EXCELLENT

### Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
- (B) Merit of the team of Integrated Researchers: 5
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 4

**Base Funding for (2020-2023):** 255 K€

### Recommended Programmatic Support

PhD Fellowships: 3

Programmatic Funding: 400 K€, including for 1 (Junior) New PhD Researcher Contract.

### Justification, Comments and Recommendations

The Institute of Microsystems and Nanotechnologies was created in 2007 and has been at the forefront of Spintronics, thin film MEMS in addition to other devices and since 2000 as a rapid prototyping unit. After 2007, it developed a focus on microsystems for industrial sensing, health and agrifood/environmental applications, including technology transfer. Researchers published a relatively good number of papers per year although not all of them are of a high impact. The Unit is active in patents and licensing demonstrating a real commercial impact of the developed technologies by researchers. The Unit is at the forefront of maintaining Portuguese lead in micro and nanofabrication, with rapid prototyping in a clean room environment. It is one of a few Units to allow for 6 inch process capability at present proposed to move to 8 inch in this proposal, that is absolutely necessary to be competitive in MEMS and sensor applications. The 6 PI's have managed significant programmes including Euro 850k from industry in the last 3 years with a view to work with society on industry related programmes. The integrated researchers have a large world-wide collaborative network and are involved in a number of European projects, including the participation in Marie Curie Innovative Training Networks (ITNs).

The researchers have successfully supervised various PhD and MSc students. In relation to the 5 highlights of the R&D Unit, there have been a number of impacts from the research over the last 5 years, including:

- (i) an integrated microsystems start-up producing commercial prototype for the dairy industry;
  - (ii) being founding members of SpinTronicFactory network,;
  - (iii) collaborations with international partners such as Fraunhofer, including an EU FET project,
  - (iv) thin-film silicon as structural layers in MEMS on glass and polymer substrates, for use in flexible electronics;
  - (v) a US patent granted in the field of advanced capillary chips with flow control and sequential fluid insertion.
- However, more information should have been provided in relation to state-of-the-art in the field and the novelty of the technologies developed by the researchers within the Unit to benchmark these against world standards.

The Unit has been successful in capturing non-FCT funding from various international sources (30%) and the European Commission. Outreach to public/school children or open access of science are not fully addressed in the documentation, although on visit it was clear this was being conducted.

The Unit should consider improvements in Health & Safety, as well as security issues in the Center. In relation to PhD students, the lack of electronic engineering and chemistry disciplines in the backgrounds of PhD and Junior integrated researchers was observed as a weakness that could probably affect the quality and relevance of the science related the devices and systems being developed, particularly for external clients.

A strategic plan is defined and includes the development of complex integrated microsystems over the next period – undertaken through core research areas of spintronics and magnetic biosensors and MEMS/BioMEMS, combined with microfluidic systems – including the development of new strategic research areas, including advanced packaging and



integration systems, simulation of devices and systems and bioelectronic interfaces. The Unit also has the foresight to increase its services over the next 5 years, reinforcing its participation in international infrastructure networks, such as KET Tools and SpinTronicFactory. There is also a good training strategy for postgraduate students proposed, including the development of new training courses in which Centre specialises, such as micro/nanofabrication training, including special training targeted as potential users of the Centre's fabrication facilities. Strategy also includes the expansion of existing and development of new undergraduate courses and a PhD internship program with national industry, which is a very positive. Spintronics and magnetic biosensors group will be tackling the 'topmost challenging problems of industry', e.g. noise and sensor performance limits – but what is novel compared to state-of-the-art? Thin-film MEMS and BioMEMS group will focus on microsystem integration, e.g. device to scan for antibiotic resistant bacteria in hospitals. What is the current state-of-art, and competition is not identified and compared to the proposed solution (section 11.1) The progress (innovation and advantages) to be done in this area is not clearly described. Also, unclear is the novelty of the strategic transversal initiatives compared to state-of-the-art and competitors in the field, particularly as these are key to the successful integration of new researchers into the Unit.

There is a plan to develop a technology transfer platform, but it is unclear from the application how this work will be done. What additional resources will be required? The plan includes a steady (and reasonable) increase in Integrated Researchers, postgraduate students and technical/secretarial staff. Most of the budget from FCT has been proposed towards service or product procurement and acquisition (65 %). New INTERFACE programs to help co-fund cleanroom infrastructure. Are the cleanrooms sustainable based on income or should this Strategy be reconsidered in light of the available resource?

The little detailed discussion about data management and the organisation of conferences/workshops led by the Unit was found to be disappointing. The Unit needs to improve the quality of the research in the area of (nano)materials. This is crucial to ensure progress beyond the state of the art in the device development and applications. In addition this will increase the quality of the publications as well as improve patenting and other activities. Attracting talented PhD and young researchers with background in electronic engineering as well as in chemistry/materials science would be very helpful.

## Evaluation Panel: **ENGINEERING SCIENCES AND TECHNOLOGIES - Materials Science and Engineering and Nanotechnology**

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**R&D Unit:** Instituto de Nanoestruturas, Nanomodelação e Nanofabricação (I3N)

**Coordinator:** Elvira Maria Correia Fortunato

**Integrated PhD Researchers:** 95

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**Overall Quality Grade:** EXCELLENT

### Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
- (B) Merit of the team of Integrated Researchers: 5
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 4

**Base Funding for (2020-2023):** 1687 K€

### Recommended Programmatic Support

PhD Fellowships: 11

Programmatic Funding: 905 K€, including for 3 (2 Junior, 1 Assistant) New PhD Researchers Contracts.

### Justification, Comments and Recommendations

The Institute of Nanostructures, Nanomodelling and Nanofabrication (i3N) is one of the leading European R&D Units in Nanotechnology, that was established in 2006. Under the Directorship of Prof. Fortunato. This activity has grown in its commitment to deliver the highest quality research, with cognisance of delivering societally impactful output in the area of Nanotechnology. The research of the Unit spans from sustainable Micro and Nanotechnology, Energy efficiency, Nanomaterials Engineering to Biomedical Engineering. With close to 250 researchers, it is a leading establishment in terms of research output with over 1500 scientific papers, more than half in high ranking journals; and cultivated over 8000 citations. Its circa 249 members include 53 academic staff, 41 Pos-Docs, 57 PhD students, 15 technicians/administrative and 83 collaborators.

The group have targeted societal issues particularly associated with advanced functional materials that include energy, man-machine interfaces, biomedical sensors, sustainable technologies; with pioneering contributions in paper electronics and transparent oxide electronics. A large number of international collaborations have been set up with some of the best laboratories in the world, with over 30% of researchers coming from overseas. The group have been extremely successful in attracting research funding and excellence awards from all types of competitive funding sources, including over Euro 38M from national, international and industry over the last 5 years.

Over the review period researchers have secured 56 international projects, including 4 ERC grants which highlights their international reputation. The researchers have published in a number of high impact, top international journals, including Science and Advanced Materials. They have also published a number of review articles on research within their fields in top journals such as Chemical Reviews and Progress in Materials Science. A number of these publications have been highly cited and many of them have given invited/plenary talks at international conferences.

Individually, the researchers have attracted significant national, international (including EU) and industry funding and have successfully filed a large number of patents over the review period – 7 with industry, 23 in Portugal and 40 international. The researchers have a large network of international collaborators and have organised and chaired a number of national/international conferences and workshops.

The researchers have also been involved in outreach with high school and university students, including summer schools and science days (such as 'European Researchers Night') for which team members have received a number of national and international awards and distinctions.

In relation to highlights for the R&D Unit, the researchers have pioneered the use of metal oxides as semiconductors in TFTs for displays – which has resulted in a patent with Samsung. Complimenting this work has been Prof. Fortunato's advanced ERC grant on transparent oxide electronics. In the area of electronics, researchers have produced sustainable and recyclable nanowires using low temperature solution-based processes for 'system-on-foil' devices and cellulose paper-based electronics, with potential applications for smart labels (food packaging) and disposable electronic devices.

In relation to modelling complex systems, further clarification is required on the applications and potential impacts of the research. Internationalisation and state-of-art analysis beyond close confines of the laboratory would have allowed a more accurate picture of the standing of the work in terms of absolute impact and societal contributions.

The Centre was established in 2006 and was a partnership between 3 leading research institutes in fundamental and applied science. After a Strategic refocus in 2018, 2 of the original R&D Units are now involved, CENIMAT and FSCOSD. 30% of institute members come from abroad, highlighting the international merit, recognition and standing of the Centre. The Centre is organised into 6 research groups, in areas such as sustainable micro and nanotechnology and energy efficiency, which will have an economic and social impact on society. Additionally, experimental research is supported by modelling within the Centre, which augments the research conducted.

The Centre is committed to raising public awareness in the areas of nano- science, engineering and technology. The institute is involved in MSc and PhD programmes, as well as international programmes, which has resulted in the training of 250 MSc and 78 PhD students over the review period.

The CVs of the team members within the groups is generally impressive, with 10 researchers being listed as having 'nuclear CVs', all with impressive publication records, particularly the lead PI's of the Centre Prof. Fortunato and Prof. Rodrigo. There is evidence that the researchers work together as teams, for example on the 'system-to-foil-concept' (devices) which involves interactions between materials scientists, engineers, physicists and chemists.

A number of significant contributions have been made by the 6 research groups, including the Collaborative research prize, Santander Totta, was awarded to the project 'Singing bronze' involving 2 teams of researchers led by Prof. Debut. Under the scope of ERA-NET projects, involving internal collaboration, a successful research project was also developed on the use of new glass materials for sensors. The Advanced Materials for Micro & Nanotechnologies Group have been successful in obtaining 4 ERC grants, and are involved in the co-ordination of 4 international projects. This group has also received 25 international awards. The Physics of Advanced Materials & Devices Group have developed an innovative positron emission tomography (PET) concept, achieved at a much lower manufacturing cost but still providing outstanding image performance. Preclinical PETs are being developed by the spin-off Ri-te. However, the interactions between groups could be more encouraged; much like the very visible interaction with external and overseas organisations.

This is one of Europe's strongest research laboratories in the field of nanotechnology. They have been training excellent researchers from MSc to PhD to postdoctoral candidates. The quality of the researchers can be judged by the output, including the journal paper quality, the research grants won and the success of the Unit to make unique contributions to the field of large area electronics. Securing 56 international programmes of research and 4 ERC grants during the review period is a great achievement. Further, 23 patents being granted in Portugal and 40 internationally show the drive towards societal impact in the work being undertaken and the push towards higher TRL levels in the research being undertaken. Furthermore, the winning of 25 international and 16 national awards of distinction to the members of the team is very impressive and shows the future talents that are available to call upon within the current researchers.

A strategy for the future has been outlined to target four research fields in Sustainable Micro and Nanotechnology, Energy Efficiency, Nanomaterials Engineering and Biomedical Engineering. Two are disciplines and two are generic areas. The Centre's research strategy is aligned with Horizon 2020 and FP9, concerning nanotechnologies, nanomaterials and nanosciences. The Centre is geared to providing service to industry and to be their strategic partner to boost their development. The future strategic plan is based on a research focussed on industrial and social challenges and the education of new researchers. Implementation of a 'triangle of knowledge' (research-industry-education) will be the enabler and key driver for scientific and technological development and innovation. The Centre also aims to include sustainability as part of its research strategy, through materials reduction and the recycling of materials, whilst maintaining high performance of devices, involving material/device design and modelling. The Centre will develop its research activity in the area of biotechnology materials and products, including life sciences, targeting particular industrial applications. The description and target science to technology path was less clear, with the specific planned activities of the Unit over the next 5 years very broad and generic (section 11.1). The linkages to the current groups and evolution of these to new areas not fully defined.

Appropriate organisational structure, involving a decision-making structure, a management and coordination structure and a support structure were included in the documentation. The involvement of the PhD students and Junior Researchers in the discussions of future directions was not apparent during the visit, as was representation of these categories in the decision making process. However, the Scientific Council, which is the main policy and decision body of the institute, incorporating all members with a PhD, only meets once a year. The efficiency of bottom-up input to the

decisions on membership, accountability and investment may be made more appropriately with more regular involvement, including minuted communications with the International External Advisory Board – made up from European experts in the field. The future directions identified within the plan to hire new researchers in strategically identified areas, such as sustainable micro and nanotechnology, energy harvesting etc., aligned to the strategies of the Universities. The strategy of enabling new ‘junior research contracts’ to ‘full-time science managers’ was less clear, as well as its buy-in from all integrated researchers (section 14.4). There was good institute commitments to participate in a number of infrastructures (collaborative laboratories) and international networks, e.g. European Multifunctional Materials Institute located in Bordeaux, France; with 40% of income generated from EU sources – an impressive target.

Education and training is a key strategy within the Centre, promoting ‘citizen’s science’, including education around eco-friendly products.

## Evaluation Panel: **ENGINEERING SCIENCES AND TECHNOLOGIES - Materials Science and Engineering and Nanotechnology**

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**R&D Unit:** Instituto de Polímeros e Compósitos (IPC)

**Coordinator:** Julio César Machado Viana

**Integrated PhD Researchers:** 23

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**Overall Quality Grade:** VERY GOOD

### Evaluation Criteria Ratings

- (A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 4
- (B) Merit of the team of Integrated Researchers: 4
- (C) Appropriateness of objectives, strategy, plan of activities and organization: 3

**Base Funding for (2020-2023):** 338 K€

### Recommended Programmatic Support

PhD Fellowships: 6

Programmatic Funding: 385 K€, including for 1 (Junior) New PhD Researcher Contract.

### Justification, Comments and Recommendations

Institute of Polymers & Composites devotes its multidisciplinary researches (both scientific and technology-based to applications) on polymer and composite science and engineering, i.e. including polymer chemistry, physics, engineering, and technology. Thus, the Centre brings together researchers with a range of disciplines, including polymer chemistry, physics, engineering, and technology and could be considered as a multi-disciplinary institute. As mentioned, the application-push approach drives the integrative and basic R&D activities of IPC. The integrated researchers have made a number of contributions over the last five years, including a number of scientific achievements, e.g. new CNT-filled thermoplastic elastomers, electrochemical sensor prototypes, the development of improved models for understanding the flow of viscoelastic polymers and the development of LCA methodologies for food packaging, etc.

IPC runs its researches within two groups: 1/ Nanomaterials and Novel Polymer Systems Group NNPS and 2/ Engineering Design and Technologies with Polymers and Composites Group, which were already running when IPC stood as a tripartite member of i3N, i.e. for the period from 2013 to 2018. As mentioned later, in the framework of the reflection on the strategy, the R&D Unit is invited to consider more research groups for bringing a better visibility to the different areas defined in the research positioning.

The research done during the past period was very good and very relevant for addressing scientific questions identified from technological challenges. In this period, the 23 Integrated Researchers produced 342 publications in international journals and 32 book chapters, i.e. about 3 items/year/IR which is a very good indicator. Even if few papers are published in high ranking journals such as ACS Applied Materials and Interfaces, Carbon, or Applied Surface Science could be identified the scientific production over the IPC researchers is very heterogeneous, i.e. there are some scientists who are authors of numerous and high quality papers whereas others published very few papers. The Unit is getting good recognition in awards and distinctions, it is continuing to perform well in publications, and also producing patents that will become valuable in time. The mobility and acceptance of the PIs is shown by the many international conference organization committees and journal editorial boards they are being invited to participate in. These links need to be translated better R&D activities that better impact society, H2020 contracts and spin-out activities. In fact, the opportunity does exist to target more of the impactful journals over the next five years.

For the technology transfer indicators, 15 patents could be noticed which is a good number but not so high considering the fields of research addressed by IPC. In fact, the researchers are very close to applicative fields, i.e. these ones could lead to more intensive transfer and creation of spin-off companies. This proximity with applications important to industrial collaborations were developed leading to a large funding and close collaborations with large companies such as Bosch. The IPC researchers were involved in a private and non-profit association collaborative laboratory, DTx Digital Transformation, joining companies, universities, etc. This initiative is very positive as it substantiates the relevancy of the research done at IPC for the Industry.

In the last period, numerous PhD students graduated and the Research Unit is strongly involved in advanced training for example with its involvement in the co-ordination of the European Master EuRheo. The Research Unit is invited to open place(s) for involving young researchers, i.e. PhDs and post-docs, in the scientific life and the decision processes. One can suggest that elected representatives from PhDs and post-docs participate to the scientific committee and that PhDs Day or specific PhDs/post-docs events will be organized to take profit of their inputs. On another hand, the Research Unit needs to have a more clear process for the management of the careers of post-docs as many of them stay in the Centre for long periods.

Significant funding obtained from international sources, other than European Commission, reflects international recognition of the Centre. A reasonable EU strategy put forward for the new period involving participation of researchers at brokerage events, promoting strategic partnerships with European research institutions to help drive this opportunity, etc. According to the scientific themes addressed by IPC, one can expect more European project involvements and initiatives to co-ordinate collaborative projects as well as applications to European calls such as Integrated Training Networks, etc., but also for technology transfer actions.

From a relevant analysis of the strengths, weaknesses, threats, and opportunities done from the recent decision to be independent from i3N, the project which is fully aligned with the running activities proposes a clear strategy for the next period. The focus on three major scientific areas based around polymer science is a good objective for strengthening the scientific strategy of the IPC Research Unit. The organization is in the rise with a well defined strategy and directions to move forward. The reduced PI of 16 also show the Unit is commensurately working well in winning contracts and maintaining publications that are internationally competitive. The Unit is on the start of the journey for more international activities, and the research funding won is showing major impact in winning significant funding. This will start to impact industry and EU in the years to come. The Research Unit intends to develop both basic research as well as looking at more applied research challenges over the next period. Such a strategy will help engagement with new companies and to develop new research topics, projects, assuming the R&D Unit will ensure to have the required scientific expertise. According to those objective, the increase in the PI number is well justified as the Unit with its strategic direction in 2017 decided to focus on key areas that can show growth in the future.

Three leading themes have been put forward which appear to tie in with the expertise of the integrated researchers involved. This will allow to manage both the production of high impact and high quality scientific productions such as papers in high rank journals and transfer or valorization of researches as patents and creation of spin-off companies. The Unit has the goal to be a flagship R&D Centre for polymer science and technology, but strategy/plan to achieve this target needs to be supported with specific actions. The planned budget is in agreement with the ambitions of the project defined in 2017.

Thus, the R&D Unit is invited to pursue the construction of the strategic research plan and to define more precisely the goals with associated milestones and indicators. In fact, the project needs to identify in a more strategic and better manner the scientific questions (which can be issued from technological requests from the collaborations with the companies) to address vs. researches to proceed to solve technological questions for proposed relevant solutions to Industry. In addition, the involvement with the collaborative laboratory, DTx, which appears as a very good vector for translation of research to technology in close collaboration with Industry, is strongly recommended as it fits well to the action plan for improving the valorization and technology transfer, i.e. the generation of collaborative research works with the Industry and the set-up of new spin-offs. Communications strategy will involve promoting research through media and a strong outreach plan needs to be developed, particularly to highlight the work going on within the Centre and to capture the interest of the public and school children.

## Evaluation Panel: **ENGINEERING SCIENCES AND TECHNOLOGIES - Materials Science and Engineering and Nanotechnology**

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**R&D Unit:** Materiais Fibrosos e Tecnologias Ambientais (FibEnTech)

**Coordinator:** Manuel José dos Santos Silva

**Integrated PhD Researchers:** 32

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**Overall Quality Grade:** GOOD (\*)

### Evaluation Criteria Ratings

(A) Quality, merit, relevance and internationalization of the

R&D activities of the Integrated Researchers in the R&D Unit Application: 3 (\*)

(B) Merit of the team of Integrated Researchers: 3

(C) Appropriateness of objectives, strategy, plan of activities and organization: 2

**Base Funding for (2020-2023): 378 K€ (\*)**

(\*) After Preliminary Hearing

### Justification, Comments and Recommendations

The Fiber Materials and Environmental Technologies Unit (FibEnTech) was created in 2012, but started from Textile and Paper Materials from 1991 based around the University of Beira. There is much scope to move forward both from a bioethanol production from lignocellulosic materials perspective and conducting research in textiles and paper. The Centre is doing research in the field of textile fibres, paper-based materials and environment related areas mostly related to water treatment. It is organized in three research groups coming from two institutes. The R&D Unit is working on: i) Environmental tech: the degradation of sanitation with electrochemical process is known everywhere; wastewater treatment; ii) Cellulose materials: films and composites with lignocellulosic materials with food packaging application, they tailor the properties and try to transfer to real life materials, as well as in modelling to optimize porous structures; iii) and finally in textiles, where one of their main achievements is manufacturing new techniques to produce antennas.

The Unit brings together researchers from a wide range of science and engineering disciplines, which is needed to tackle the challenges outlined in the proposal and the needs from the industries in the area and other places of the country. How these individual researchers come together to tackle the big challenges outlined was not clearly defined in the application. Whilst there are 2 complimentary groups mentioned in the proposal (Fibre Materials and Environmental Technology), how individuals contribute to these groups and how these groups interact together is difficult to decipher from the application. Additionally, evidence of joint publications between the Integrated Researchers is lacking which might suggest that researchers are working within their own silos. The reported brief descriptions of the 5 contributions of the R&D Unit are not supported by impact papers, patents, spin-off companies or other highlighted achievements. The excellent 'key highlighted' programmes' should be showcased better, and the benefits to the Unit shown due to these collaborations. Novelty in cellulose group is how to produce papers – but using standard techniques. There is not enough evidence of the progress beyond the state of the art in either materials (cellulose related) or developed platforms (for example wearables). Innovation and advantageous aspects in these areas are non-existent or very weak.

Unfortunately, the strategic imperative of what is being proposed is less clear, although there is much information contained within the documents submitted. The challenges that can be tackled in wastewater treatment, wearables of the future, bio-functionalised textiles, environmental mitigation have all been discussed; but how they fit into a coherent strategy moving forward is not clear. The Unit appears to be supported very much from FCT resource but more recently has had funding from companies and other national sources. For the size of the Unit, the output and contributions to society are modest. The external footprint too is not fully made although there are some excellent cases of industry interactions.

The Unit and the individual integrated researchers certainly have a scientific presence in Portugal, but evidence of international recognition of the teams within the Unit needs to be better defined. As a Unit the team appear to attract funding from Portuguese companies and interacting with local authorities but not at international level. Only few integrated PhD researchers have performed R&D of national and international quality and merit. Other researchers have performed R&D of limited quality in the field of sensing platform applications between others. How the PIs have progressed their respective programmes to grow activities, and encourage more PhD and other research programmes is

not fully visible. The documentation is less clear on the awards and distinction of individuals involved and maybe this can be better structured in the paperwork presented.

The number of PhDs coming out with respect to the PIs appear to be low, with little or no research contacts with international bodies. There is little/no discussion about training of postgraduate students or the career development of postdocs in the proposal or in the Unit's web-site. No discussion about outreach activities within the Unit to promote/educate people about the research going on within the Unit and environmental challenges. There is little mention of open science policy or data management within the application.

The R&D Unit is lacking focus given the many and various research activities and lines identified. The science proposed is not of high level and there is little analysis to identify strengths and weaknesses. Strategy for international collaborations, given the large number of competitors (or collaborators) working in the field, does not seem to be adequate. The structure/organisation of the Unit is not clearly defined particularly in relation to managing scientific or organisational issues.

In this R&D Unit the parameters on how to increase the research level and to attract talent are missing. They have difficulties to recruit students. They also seem to have difficulties to construct the roadmap of the Unit and to implement the roadmap continuously. The numerous topics they work on are very high compared to the number of integrated researchers constituting the Unit. The demographics of the Unit does not sit well with an internationally competitive field of research such as textiles. The Unit lacks international collaboration. The research expertise is very similar to many other international groups, which means the competition is very high. They claim to be leaders in some of the research areas, but their citation record and other metrics are poor.

The Center needs to clearly define its research strategy, including research lines with novel ideas and convincing objectives about their progress beyond state of the art. Among the current research lines the Center should carefully select only few to pursue in which they consider impactful in terms of both science and technology. The future research strategy should consider not only the current human resource but also ways to attract new talent.