University Alliance
Doctoral Training Alliance

DTA3/COFUND Programme Research Project Proforma

Page 1 – General Information

Project Code	SHEN01
Partner University	Sheffield Hallam University
Faculty/School/Department/Research Centres	ACES/Engineering & Maths/MERI
First supervisor Please provide name and weblink	Dr Sima Aminorroaya Yamini https://www.shu.ac.uk/about-us/our-people/staff-profiles/sima-aminorroaya-yamini
Second supervisor Please provide name and weblink	Professor IM Dharmadasa https://www.shu.ac.uk/about-us/our-people/staff-profiles/im-dharmadasa
Third supervisor Please provide name and weblink	Dr Abhishek Asthana https://www.shu.ac.uk/about-us/our-people/staff-profiles/abhishek-asthana
Fourth (external) supervisor	Dr Mahboobeh Shahbazi https://staff.qut.edu.au/staff/mahboobeh.shahbazi/
External/industrial supervisor	N/A
Which of the supervisors listed above is an early-career-researcher	Dr Mahboobeh Shahbazi
Contact details for project for informal applicant queries Email address	Dr Sima Aminorroaya Yamini S.Aminorroaya@shu.ac.uk
DTA Programme: Please delete as necessary which DTA programme this project relates to:	DTA Energy
Project title	Developing high performance thermoelectric materials for low to medium temperature applications

Co-funded by the Horizon 2020 programme of the European Union

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 801604.

Page 2 – Project Description

Scientific Excellence (500 words)	Solid-state thermoelectric generators (TEG), which convert heat to electricity directly and vice versa, are considered pioneer candidates for industrial waste heat recovery and electronic cooling. However, existing thermoelectric (TE) materials have relatively low conversion efficiency. This project goal is to understand the contribution of secondary phases and interfacial chemistry on electronic transport properties of bismuth telluride (Bi_2Te_3)-based TE materials in order to improve their thermoelectric conversion efficiency. This will advance fundamental knowledge of functional materials, address technological challenges and enable UK researchers to compete internationally in the highly challenging field of energy harvesting and energy savings.
Aim (400 words)	The aim of this project is to develop high performance Bi_2Te_3-based TE materials. Major developments on Bi_2Te_3 have been based on single-phase alloys, whereas our recent studies have shown higher efficiencies in multiphase TE compounds compared to the single-phase materials. The principal goals of the current proposal can be split into designing high performance TE materials and incorporating them into devices. The innovative aspects of the project are: - Designing and synthesis of novel high performance TE materials. - Adopting novel techniques to characterise these materials. - Developing fundamental understanding of chemical heterogeneity on transport properties of multiphase TE materials.
Strategic Relevance (300 words)	The Bi_2Te_3 thermoelectric materials in the TEG market accounted for the largest share of ~ US$349M in 2017 and are projected to lead during the forecast period to 2023. This project provides international exchanges, knowledge transfer

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	and directly addresses all four of SHU's Transforming Lives strategy pillars, generating world-leading science that provides innovative solutions to real-world problems. It will produce multiple REF publications, grow key collaborations and support development of a world-class energy conversion research group at SHU. Developing materials that enable high efficiency TEGs will pave the way to extensive engagement with industry and to substantial future grant funding through independent and joint proposals with established thermoelectric groups and will support SHU involvement in future Hubs, Networks and DTCs. This project will expand the DTA energy programme, adding a new research field (thermoelectrics). The DOS is willing to introduce an elective on "thermoelectrics" within DTA-Energy, complementary to the elective delivered by the second supervisor (Dharme). The student will work closely with supervisors, students and PDRA's in MERI and benefit from spending of ~3 months in the collaborative institutes and close collaboration with industry partner. S/He will attend professional development, summer school and support undergraduate teaching.
Interdisciplinarity and fit with DTA3	The researcher will benefit from working closely with an interdisciplinary team of supervisors, students and PDRA's in MERI and at the university and industry partners. This project will strengthen existing collaborations to accelerate the work and maximize research outcomes. It will also develop fundamental understanding of composition/structure/property/phase relationships on electronic transport properties and provide a platform for high quality training of researchers in understanding challenges/breakthroughs in energy efficiency and harvesting.
Industrial Relevance (300 words)	The DOS has existing collaboration with European Thermodynamics Ltd. to incorporate developed materials in a thermoelectric module and test for performance. Although the exact design according to the final application of the thermoelectric modules will emerge as the project progresses,

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	we plan to integrate the developed materials in existing designs, to determine their impact on the efficiency of the device, compared to existing products. The company has offered to provide simulation results and guidance on the impact of the outputs from the materials developed by experiments and will investigate the performance by building a small demonstrator prototype. The researcher will collaborate closely with the industry partner R&D team to endeavour the goals set within the project.
Economic and Societal Impact (300 words)	**Economic impact:** The new strategy introduced in this proposal will produce high efficiency thermoelectric materials and advance manufacturing of thermoelectric generators for large-scale industries, which produce significant amounts of waste heat (> 50% of the consumed energy), such as metal processing, fossil and geothermal power generation plants. The outcomes of this project will enable the technology of self-powered wearable thermoelectric module manufacturing, which is an emerging field with new exciting applications including *self-powered* wearable electronics, health and performance monitoring devices, sensors and communications equipment. Since the materials developed will have direct application to heat recovery technology, the prospect of producing a commercial product from the IP generated by this work is very real. It will strengthen the research and patenting position of the team. **Social impact:** This project promises the development of maintenance-free highly efficient waste heat recovery into electrical energy, which improves energy efficiency and reduces the carbon emission generated by industries. This directly addresses COP 21 targets and UK ambitious targets for energy and CO_2 reduction of 80% by 2050. It will also support sustainable industrial development. This project provides an exciting platform for high quality training of young researchers in understanding challenges and breakthroughs in energy harvesting. Early stage investigator, through this project, will have exceptional opportunities to gain

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	skills in an interdisciplinary area and work with internationally known experts through collaborations with universities and the industry partner. Generating high performance TE materials could also lead to new high-skilled jobs and offer a technology platform to other industries.

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Page 3 – Admission Requirements

Specific Admission Requirements Detail any subject specific degree qualifications or disciplines, relevant skills, experience	A graduate with first class or 2-1 degree in materials science or physics will be most suitable for this project. An MSc. Degree will be an added advantage.
Minimum IELTS score	6.5

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