PI name & contact details:	Prof Igor Shvets; Tel: +353 1 896 1653 e-mail: ivchvets@tcd.ie
School: ***Has project been agreed with head (or nominee) of proposed registration school?***	Physics
Research Centre / group affiliation:	Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN) School of Physics – Applied Physics Research Group
Research group / centre website:	www.tcd.ie/Physics/applied-physics www.crann.tcd.ie
PI website / link to CV:	www.tcd.ie/Physics/applied-physics

Brief summary of PI research / research group / centre activity (2 or 3 lines max):
Multidisciplinary group working at the crossroads of physics, chemistry and materials science. The group research primarily related to the surfaces and interfaces of oxides, surface science, thin films, nanotechnology and computational physics in support of the experimental research. The group is a multicultural group of some 18 members, affiliated to the School of Physics and the Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN).

Title & brief description of PhD project (suitable for publication on web):

Hole mobility in substituted transition metal oxides

Semiconductor materials which conduct via electrons (n-type) and holes (p-type) are the basis for conventional electronics in so much as they form the respective layers in p-n junctions. The fundamentals of n-type conduction and p-type conduction are well understood for semiconductors. However, this situation does not extend to transparent semiconductors, which many commentators suggest will form the basis of the next generation of electronics, transparent electronics.

To make transparent electronics a reality we need to have transparent n-type and p-type semiconducting materials. To date, the best candidates are Transparent Conducting Oxides (TCOs). While n-type Transparent Conducting Oxides are readily available there is a dearth of technologically relevant p-type TCOs. The reasons for this are primarily due to low hole mobility, residual absorption or unfavourable band offsets.

This PhD project is primarily concerned with the synthesis of novel p-type TCOs via MBE growth and anionic-cationic substitution. The MBE growth is to ensure the project is working with high quality epitaxial thin films. Substitution paradigms will be developed through co-doping of suitable cations and anions at deposition time. The ultimate project goal is to fabricate p-type TCOs with increased optical transparency and electrical conductivity and developing an understanding of the fundamentals of cationic-anionic substation related effects.

The project will encompass MBE growth of epitaxial and substituted Transparent Conducting Oxides and their subsequent optical, electronic and structural characterisation. Optical characterisation shall be via ellipsometry and UV-vis spectroscopy. Electrical characterisation will be via transport measurements using standard 4 probe techniques and mobility studies using the Hall effect and Seebeck effect. Structural characterisation will be via High Resolution X-Ray Diffraction.

Completion of the project will advance the state-of-the-art in terms of p-type Transparent Conducting Oxides.

This is an exciting project focused on a topic which is gaining in popularity. There is a vibrant international community working in this field with which the Applied Physics Research Group

collaborates, both academically and industrially. The project offers the successful candidate the opportunity to work in a multidisciplinary environment, on the cusp of physics, chemistry and materials science. The project also offers the successful candidate possible commercialisation exposure based on the results of the project.

Unique selling points of PhD project in TCD:
projects should offer something that's not available in Brazil – specific equipment, multi-disciplinarity, aspects of structured programme, links with industry, placements, links with other research groups etc.

The Trinity PhD is a structured PhD and students can access discipline-specific training, as well as generic and transferable skills. All PhD students are eligible to participate in the Innovation Academy which offers a Postgraduate Certificate in Innovation and Entrepreneurship to assist PhD students identify and exploit the value within their research.

The Applied Physics Research Group can offer state-of-the-art research infrastructure in its laboratories in the School of Physics and Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN). The group is multicultural and home to students from all walks of life and offers a stimulating intellectual environment in which students can influence the direction of their research. The group also has a history of research commercialisation, so there is the potential for involvement in research commercialisation.

Name & contact details for project queries, if different from PI named above:
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Please indicate the graduates of which disciplines that should apply:
Physics
Chemistry
Materials Science
Computational Physics
Theoretical Physics

Ciência sem Fronteiras / Science Without Borders Priority Area:
Please indicate the specific programme priority area under which the proposed PhD project fits- choose only one (tick box):

Engineering and other technological areas	
Pure and Natural Sciences (e.g. mathematics, physics, chemistry)	✓
Health and Biomedical Sciences	
Information and Communication Technologies (ICTs)	
Aerospace	
Pharmaceuticals	
Oil, Gas and Coal	
Renewable Energy	✓
Minerals	
Biotechnology	
Nanotechnology and New Materials	✓
Technology of prevention and remediation of natural disasters	
Biodiversity and Bioprospection	
Marine Sciences	

Creative Industry	
New technologies in constructive engineering	