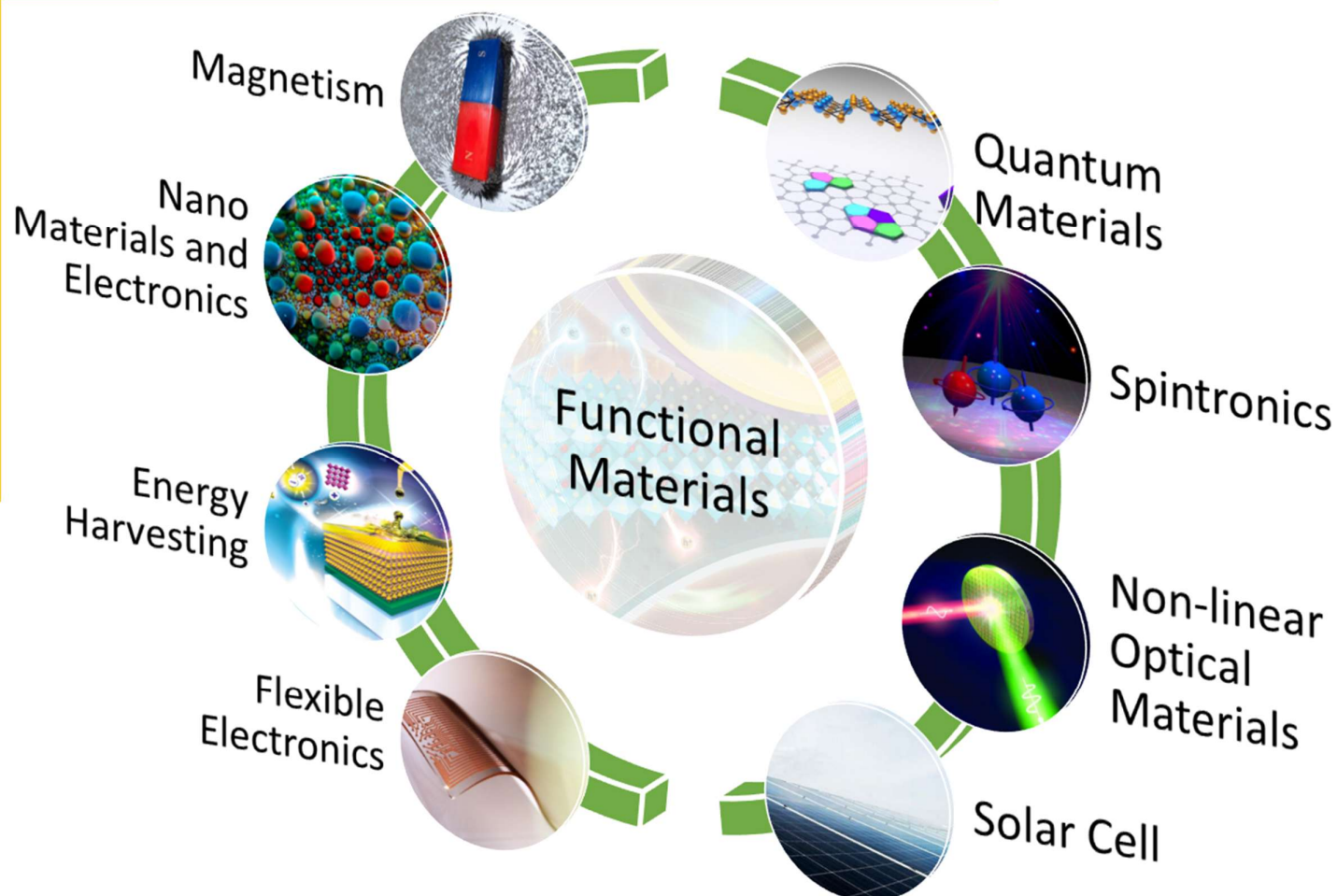




VIT[®]

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)



Centre for Functional Materials (CFM)

Vellore Institute of Technology, Vellore

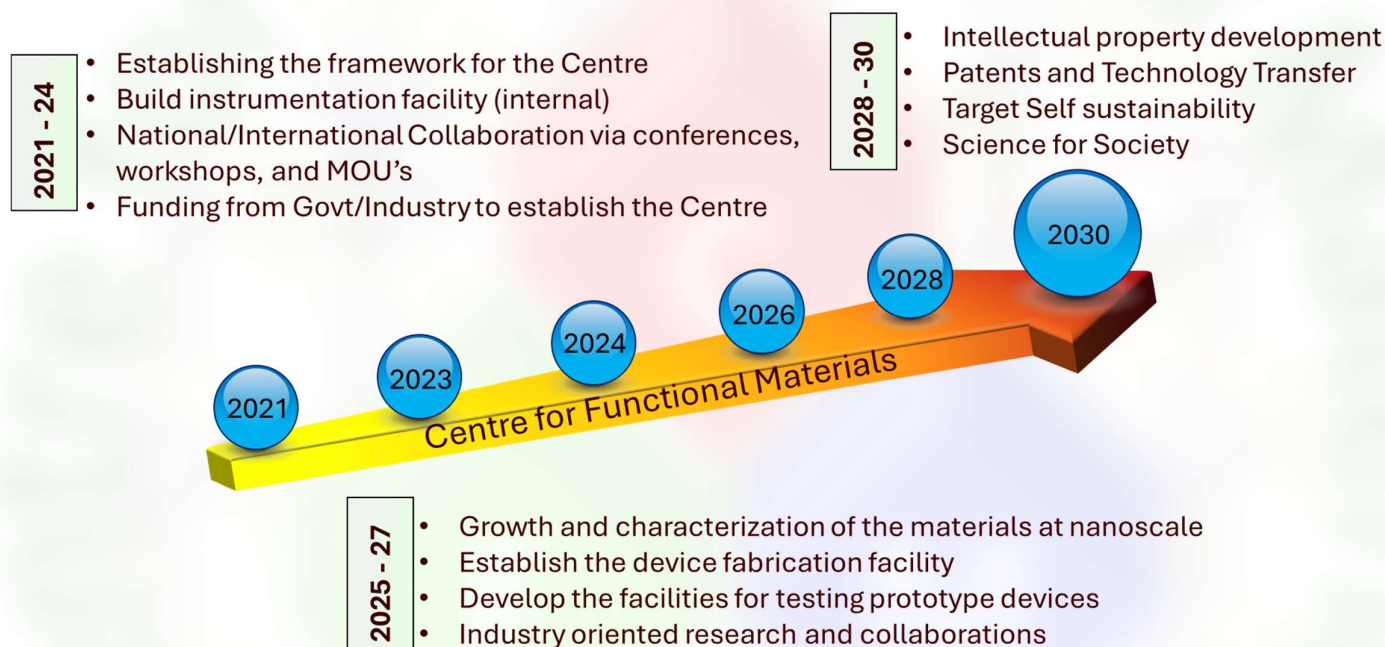
Overview of the Centre

The Centre for Functional Materials (CFM) (Formerly Centre for Crystal Growth – CCG) at VIT, Vellore was established in December 2016. Functional materials are materials which exhibit responses against external output and it covers different material classes ranging from semiconductors to polymers and molecular crystals to nanoparticles. We are working on developing tailor-made functional and nanostructured materials for renewable energy, health and environmental sustainability.

Our research focuses mainly on crystal growth, thin film fabrications, nanomaterials, ceramics, biomaterials, polymers, laser shock wave processing, metals, magnetic materials and optical materials.

CFM has eight core faculties and more than 45 research scholars and project associates. The Centre faculty are actively engaged in teaching various courses in “M. Sc., Physics” and undertaking research projects for M.Sc., and Ph. D. Scholars.”

Strategic Plan



Vision and Mission

Vision

To be locally and globally recognized in cutting-edge research, education and innovation related to functional materials, ultimately catering to the societal needs.

Mission

To explore creating most advanced facilities for functional materials research through national and international projects.

To employ world-class scientists who are experts in the field and address the nation's research challenges.

To enable the members to carry out high-impact functional materials projects.

To design and implement research oriented and industry-ready curriculum at the post-graduate level.

To develop and strengthen collaboration with universities, institutes and industries at the global level leading to patents, product development and technology transfers.

Goals and Objectives

Preparing, processing and exploring structure-property correlations in functional materials at the bulk and nanoscale resulting in accelerated new materials development.

Specific development of functional materials for sensors, magnetic storage, energy conversion, communication, various electronic and multifunctional devices including energy harvesters, actuators and transducers..

Centre Team and Expertise

Dr. Madhuri W, Professor and Director, Rigid and flexible screen, 3D-printed materials, Electro-ceramics, Amorphous magnetic alloys, ME composites, Nanocomposites, Energy harvesting storage and conversion, EMI shielding, and MEMS.

Dr. Ezhil Vizhi R, Professor, Functional magnetic materials, Development of nanostructured M-Type hexaferrite and its nanocomposites for permanent magnet and EMI Shielding Applications, Superparamagnetic nanoparticles using bio compatible polymers for magnetic hyperthermia, Semi-organic Single Crystals for Nonlinear Optical Applications, 2D-Metal Oxide semiconductor materials for solar energy conversion, Dilute Magnetic Semiconductors for Spintronics Applications, Ceramic Composites and Multiferroics for Energy Storage Applications.

Dr. Palanisami N, Professor, Ferrocene conjugated Donor- π -Acceptor Chromophores, Main Group Borasiloxanes and BF_2 Complexes for Non-Linear Optics, Aggregation-Induced Emission, Fluorescence Resonance Energy Transfer active Luminescent materials, Dye-Sensitized Solar Cells, and Colorimetric Sensors.

Dr. Ramesh M Thanankar, Professor, Low dimensional Materials, Physics at Nanoscale, Artificial synapses, Neuromorphic devices and Computation, Resistive switching devices, Spintronic devices, Molecular Materials, Molecular electronics, Materials Design for Single Photon Emitters, Qubits, Surface Science, Structure-Property relations in Materials.

Dr. Atul Thakre, Associate Professor, Neuromorphic Memory & Computing Devices, Thin Film Electronics, Ferroelectric, Piezoelectric, and Pyroelectric Materials for Sensor and Energy Applications (Energy Density Capacitors and Energy Harvesters).

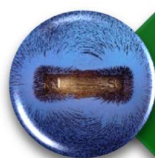
Dr. Saikat Chakraborty, Associate Professor, Polymer physics, Soft matter and biophysics, Statistical mechanics, Computational material science, Modeling and numerical simulations.

Dr. Ankur Rastogi, Assistant Professor, Functional oxides and superlattices, Interface engineering (Complex oxide heterostructure and Interfaces), Magnetism, Spintronics, Spin Seebeck effect (Spin current generation at ferri/ferromagnetic insulator and metal interface), Resistive memory, and Supercapacitors.

Dr. Amlan Das, Assistant Professor, Laser material processing (Surface and bulk micro/ nano-structuring), Light-Matter Interaction (Plasma Physics, Beam Propagation effects), and Adaptive Optics for Optical Memory Devices.

Major Area of Research

Functional Materials for energy, sensing, and memory application



Nano Magnetism and quantum materials



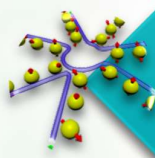
Multiferroics and elector ceramics for energy



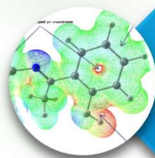
Magnetic materials for energy and shielding



Neuromorphic Computation



Spintronics and magnetic memory



Nonlinear optics and laser processing

Research Infrastructure

Thin films Deposition Facilities

Pulsed Laser Deposition



Pulsed Laser Deposition (PLD) is a PVD technique used to deposit thin films of multi component materials. It involves directing a high-energy laser beam onto a target, which ablates the atoms of the target material. The ablated particles form a vaporized plasma and are then deposited on the substrate. A key advantage of PLD is that it yields high-quality stoichiometric thin films. It is a versatile technique for depositing multi component materials like complex oxides, nitrides, etc. It also allows precise control of the thickness of the film. PLD-deposited films have broad applications in semiconductors, memory devices, spintronics, sensors, solar cells, superconductors, etc. (Venue – TT 402)

Other Thin Films Deposition Techniques

Thermal and E-beam evaporation are most common physical vapor deposition methods. Thermal evaporation heats a source material until it vaporizes, depositing a thin film on a substrate, suitable for various materials. E-beam evaporation uses high-energy electrons

for precise control, ideal for high-purity and high-melting-point materials. Magnetron DC and RF sputtering are one of the key thin-film deposition facility. DC sputtering is favoured for conductive materials for thick electrodes due to its simplicity and high deposition



rates. RF sputtering uses radio frequency power, allowing the sputtering of both conductive and insulating materials,

Chemical Vapor Deposition (CVD) involves volatile precursors reacting on a substrate to form high-quality, uniform thin films with good adhesion. CVD is used in electronics, optics, nanotechnology, and for creating wear-resistant coatings. It also plays a crucial role in advanced material engineering for aerospace, biomedical, and energy applications, including lightweight materials, biocompatible medical device coatings, and efficient thin films in solar cells, fuel cells, and batteries. (Venue – TT 402)

Microwave and High Temperature Furnaces

High-temperature muffle furnaces and microwave are heating apparatus used for fast, precise material processing. Microwave muffle furnaces utilize the microwave energy for rapid, homogenous heating, ideally suited for ceramics sintering and metal heat treatment. High-temperature muffle furnace provides homogenous as well as precise temperature control up to 1600 °C. They find their place of use in ceramics, metallurgy, and materials science processes, where high-temperature treatment is required. They are also used in environmental studies, pharmaceuticals, and schools for various thermal treatments and material analysis. (Venue – TT 402)

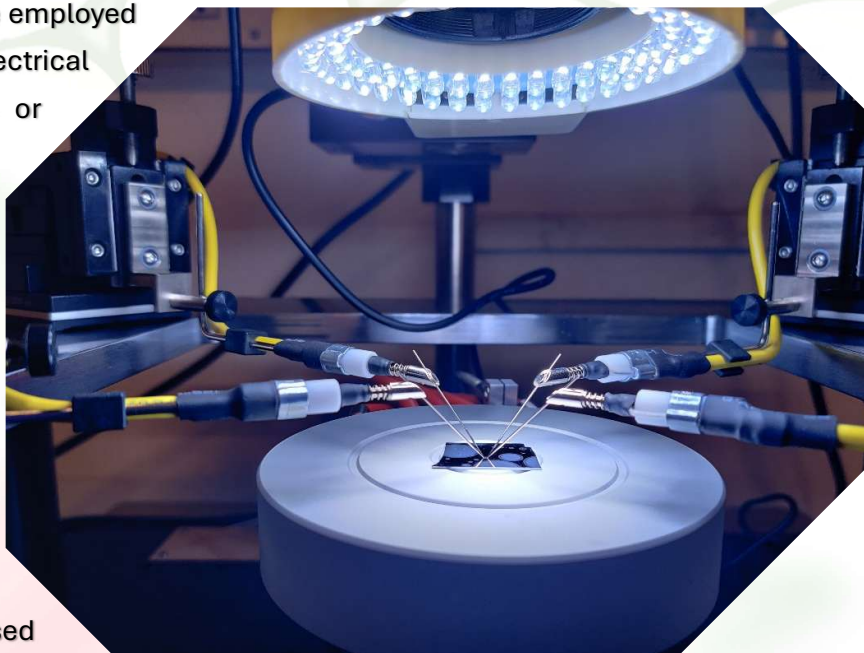
Vicker's Microhardness

Vickers microhardness testing evaluates the hardness of materials through the indentation of materials with a diamond pyramid load. The length of the indentation's diagonal is used in measuring the value of the hardness of materials. The process is

useful in evaluating the mechanical properties of coatings, thin films, and small components. Electronics, metallurgy, and aerospace industries employ Vickers microhardness testing to perform quality control, materials science, and verification of performance and durability of micro-scale coatings and components. It is a valuable tool in the development of advanced materials and the optimization of manufacturing processes. (Venue – TT 402)

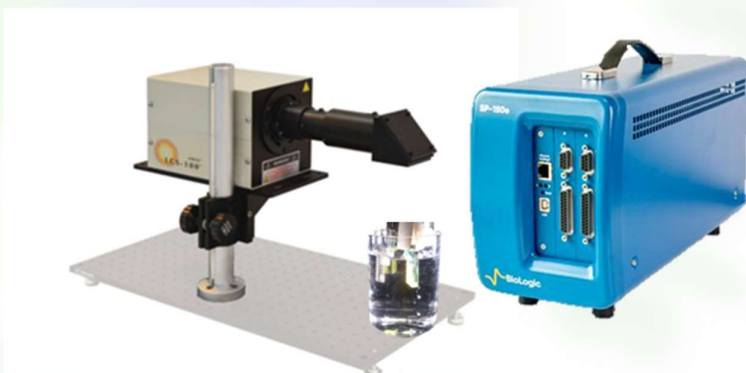
Device Characterization Facility

Probe station is a sensitive device employed in the measurement of electrical parameters from small devices or sensitive materials, e.g., organic semiconductors, microchips, and MEMS devices. Probe station can precisely position probing tests to check electrical parameters. The probe station is connected with Keysight Source Measurement Unit (SMU) for measuring voltage or direct current (DC) while sourcing or sensing them as well. SMUs are used



to characterize semiconductor devices, low-power ICs, and LEDs. SMUs and probe stations combined play an important role in semiconductor production, electronics research, and telecommunication industries to provide device reliability and performance assurance. (Venue – TT 402)

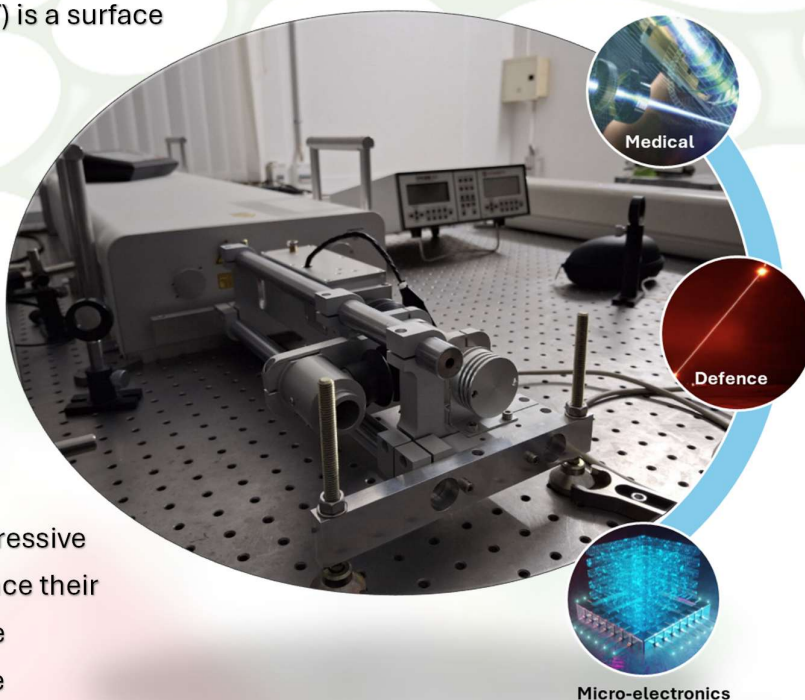
The electrochemical workstation is used to investigate corrosion, battery tests, and electrodeposition. It plays a significant role in energy storage solution development and material analysis in research and development. A solar simulator ensures steady, predictable illumination like the natural sun's rays, critical to test photovoltaic materials, devices, and coatings. Renewable energy companies, especially the manufacture of solar cells,



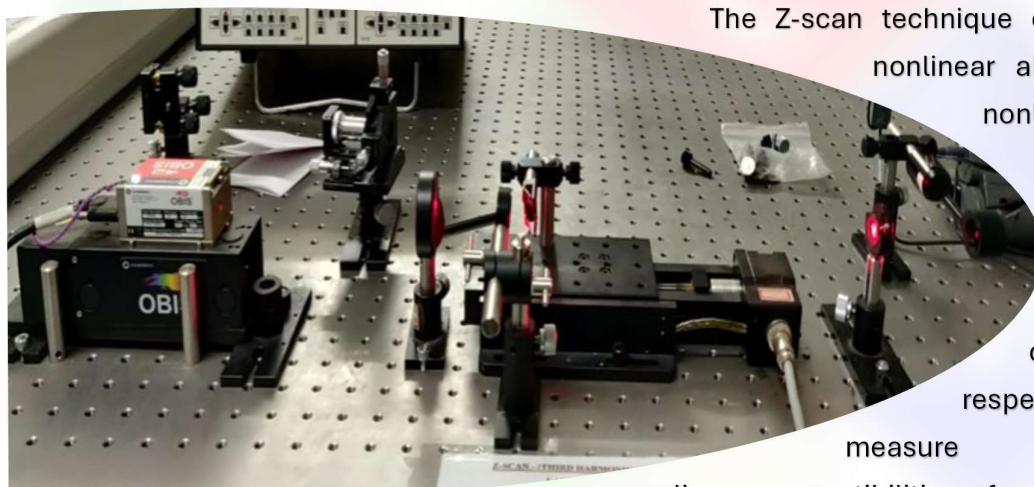
substantially depend on solar simulators for the evaluation and optimization of their performance. All of these instruments enhance research in materials science, environmental testing, and energy. (Venue – TT 505 A)

Laser Shock Wave Pinning and Damage Threshold

Laser induced damage threshold (LIDT) is a surface modification process in which a highly intense laser beam is focused on a material. This parameter helps us detect the limit at which laser fluence is enough to create morphological changes on the surface that can be functionalized optically. While Laser shock peening (LSP) is a surface treatment technique that uses high-energy laser pulses to generate shock waves, inducing compressive residual stresses in materials to enhance their mechanical properties, such as fatigue strength, wear resistance, and damage tolerance. (Venue – TT 402)



Z-scan



The Z-scan technique can rapidly measure nonlinear absorption (NLA) and nonlinear refraction (NLR) in solids, liquids, and liquid solutions by using open-aperture (OA) and closed aperture (CA) respectively. It is used to measure intensity-dependent nonlinear susceptibilities of materials. This method

uses a single tightly focused laser beam as the pump beam. (Venue – TT 402)

Sponsored Research

- ☛ Ferrocene-Appended Multidimensional (X-, Y-, V-, T- and H-shaped) Push-Pull Heteroaromatic Chiral Chromophores for Second-Order Nonlinear Optics, Rs. 6,00,000, funded by DST-SERB.
- ☛ Atomic characterization of defects in hexagonal Boron Nitride (h-BN): Towards Single Photon Emission (SPE), Rs. 1,35,000, funded by UGC-CSR.
- ☛ MoS₂/CaF₂ Nanocomposite based Resistive switching devices for Neuromorphic applications, 32,00,000, funded by DST-SERB.
- ☛ Fabrication of magneto ceramic MEMS By 3D printing, Rs. 29,00,200 by CSIR ASPIRE.
- ☛ Lattice strain and defects analysis of epitaxial thin films and single crystals by high-resolution X-ray diffraction (HRXRD), Rs. 1,45,00,000 by FIST DST.

Performance metrics



Total Publications: 438

h-index: 40

Citation: 7748

Patent Published: 15

Patent Granted: 02

Recent Patents Granted/Published

- Enhanced Magnetic Performance of Spark Plasma Sintered Hard/Soft Ferrite Nanocomposites Synthesized Via a Modified One-Step Citrate-Gel Combustion Method, App. No.: 202541071617
- Mott Insulator Vanadium Dioxide-Based Optical Morse Code Receiver System, App. No.: 202641096628.
- Absorption-Dominant Rare-Earth MOF and MXene Based Flexible Polymer Composite for Electromagnetic Interference Shielding App. No.: 202641066837

Research Collaborative Activities

MoU

- Memorandum of Understanding on student exchange with Akita University, Japan.
- Memorandum of Understanding on international partnership programs with Universidad de Aveiro (UA), Portugal.

International collaborators

• Queensland University of Technology, Australia	• Jana Dlugosza University of Cze stochowa, Poland
• VTT technical Research Centre, Finland	• National University of Singapore
• University of Tokyo, Japan	• Nanjing University, China
• Shizuoka University, Japan	• University of Cincinnati, U.S.A.
• Universidad de Aveiro (UA), Portugal	• University of Milan, Italy
• Coventry University, UK	• Osaka University, Japan

Contact Us

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