Dr Edward Tarte BSc, PhD, CPhys, FInstP

Lecturer

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About

Edward Tarte is a Lecturer in The School of Electronic, Electrical and Computer Engineering.

Edward has published over 80 research papers in scientific journals and is has been a co-inventor for two patents. These relate to the development of novel electronic devices and sensors and their applications in neuroscience. He has been funded by The UK Engineering and Physical Sciences Research Council, The European Union under Frameworks 5 and 7, the Royal Society and the UK Ministry of Defence.

He is interested in the application of the ideas and techniques of electrical engineering to biomedical science. In particular, he has used microfabrication and nanofabrication techniques to construct a number of devices designed to detect bioelectric signals. These sensors have applications in basic neuroscience and the development of prosthetic devices. He is also interested in the more general physics and applications of microfabricated sensors and actuators.

Qualifications

- Fellow of Institute of Physics 2008
- PhD in Physics, University of Cambridge, 1993
- BSc (Hons) in Physics, University of Bristol, 1988

Biography

Edward Tarte graduated in 1988 with an BSc(Hons) in Physics from the University of Bristol. He went on to study for a PhD in Physics at the University of Cambridge, during which he investigated electric current transport across the interface between noble metals and the oxide superconductor $YBa_2Cu_3O_{7-x}$.

Between 1992 and 1995 he was a Post-Doc in the Cambridge Materials Science and Metallurgy department working on Josephson junctions based on oxide superconductors.

In 1995 he was appointed as a Senior Assistant in Research In the Cambridge Physics department, where he continued to work on oxide Josephson devices with a focus on grain boundary junctions. During this period, he also began working on Superconducting Quantum Interference Devices (SQUIDs) and devices based on superconductor/ferroelectric heterostructures.

In 2000 he was awarded an EPSRC Advanced Fellowship in the Materials Department in Cambridge. During this period, he investigated the use of SQUID sensors to detect neuronal activity in-vitro. This involved a close collaboration with colleagues at Chalmers Technical University in Gothenburg Sweden. In parallel, he maintained an interest in the Josephson effect in a range of systems, including the newly discovered MgB_2 and devices with ferromagnetic barriers.

Edward moved to Birmingham in 2005 as a University Research Fellow, where his interest in the detection of bioelectric phenomena developed into a major part of his research program. His team developed an electrical interface for the peripheral nervous system, in collaboration with colleagues in Cambridge and King's College in London, which has been patented. Other ways of applying the same technology to bioelectric phenomena are being developed as well as the use of nanofabrication techniques to improve the performance of such devices. In parallel, he has maintained an interest in superconducting and oxide based devices with applications as quantum devices and as actuators.

Teaching

Teaching Programmes
- 1st Year: "Techniques of Analysis and Modelling" (Engineering Mathematics)
- 2nd Year: "Electronic circuits and devices" (Analogue Electronics)
- 3rd Year BEng projects
- 4th Year MEng projects
- MSc projects

Postgraduate supervision

Edward is interested in supervising research students in the following areas:
Biomedical Electrical Engineering
Sensors and Actuators based on oxide heterostructures

Research

RESEARCH THEMES
Microfabrication, device development for electrophysiology, thin film growth, nanotechnology.

RESEARCH ACTIVITY
Biomedical Electrical Engineering

Over the last 10 years Edward has been developing sensors and systems which can be used to detect bioelectric signals. This began with the use of SQUIDs to detect biomagnetic fields, but is now centred on microfabricated electrode arrays. These arrays are based on polymeric materials which are processed using microfabrication techniques. Polymers have the advantage over materials such as silicon of a lower Young's modulus, which results in more flexible and softer devices, better matched to the mechanical properties of nervous tissue. The flexibility makes it possible to construct devices such as the Spiral Peripheral Nerve Interface (SPNI) which is fabricated using photolithography as a flat structure on a silicon handle wafer and then rolled to fit the three dimensional structure of a nerve. This device contains channels, into which regenerating nerve fibres grow, with electrodes in the base. These channels not only guide the fibres past the electrodes, the confinement of the extracellular fluid causes the voltage detected by the electrodes to be enhanced. This technologies are being applied to a range of other applications in neuroscience and electrophysiology. We are also interested in using nanotechnology to enhance the performance of these devices by nanotexturing the surfaces of the electrodes and other areas of the devices, to decrease electrochemical impedance and enhance biocompatibility.

Sensors and Actuators based on oxide heterostructures

Many of the insulating or conducting (but not superconducting) oxides investigated for superconductive electronics have important electronic properties in their own right. BaTiO3 and related materials have ferroelectric and piezoelectric properties, whilst materials such as SrRuO3 are ferromagnetic. Edward's work in this area began with the development of SQUIDs based on oxide superconductors. He has also Josephson junction oscillators to investigate the properties of ferroelectrics in resonator structures. This effort has recently moved away from low temperature devices to the development of sensors and actuators designed to operate at room temperature. By varying the sequence and composition of layers in an oxide heterostructure, it is possible to control the orientation of a piezoelectric such as BaTiO3. Conducting oxides such as SrRuO3 can be used as electrodes and so the use of a sacrificial base layer allows a free-standing structure to be produced. This allows piezoelectric cantilevers to be fabricated, whose motion vibration can be used to sense motion. These devices have a range of applications, including energy harvesting devices.

Other activities

• Member of EPSRC Review College
• Co-author of European Roadmap on Superconductive Electronics.
• Gives talks to school groups on Electricity and Magnetism

Publications

1.Lacour, S.P., R. Atta, J.J. FitzGerald, M. Blamire, E. Tarte, and J. Fawcett, (2008) Polyimide micro-channel arrays for peripheral nerve regenerative implants. Sensors and Actuators a-Physical,. 147(2): p. 456-463. DOI: 10.1016/j.sna.2008.05.031

2.Sinha, U., A. Sinha, and E.J. Tarte, (2008) On transmission line resonances in high T-C dc SQUIDs. Superconductor Science & Technology,. 21(8): p. 085021. DOI: 10.1088/0953-2048/21/8/085021

3.Benmerah, S., S.P. Lacour, E. Tarte, (2009), Design and Fabrication of Neural Implant with Thick Microchannels based on Flexible Polymeric Materials. Embc: 2009 Annual International Conference of the Ieee Engineering in Medicine and Biology Society, Vols 1-20,: p. 6400-6403.

4.Lacour, S.P., J.J. Fitzgerald, N. Lago, E. Tarte, S. McMahon, and J. Fawcett, (2009) Long Micro-Channel Electrode Arrays: A Novel Type of Regenerative Peripheral Nerve Interface. Ieee Transactions on Neural Systems and Rehabilitation Engineering,. 17(5): p. 454-460. DOI: 10.1109/tnsre.2009.2031241

5.Magnelind, P., D. Winkler, E. Hanse, and E. Tarte, Magnetophysiology of Brain Slices Using an HTS SQUID Magnetometer System. (2009) Applications of Nonlinear Dynamics-Model and Design of Complex Systems: p. 323-330. DOI: 10.1007/978-3-540-85632-0_26

6.Anders, S., M.G. Blamire, F.I. Buchholz, D.G. Crété, R. Cristiano, P. Febvre, L. Fritzsch, A. Herr, E. Il'ichev, J. Kohlmann, J. Kunert, H.G. Meyer, J. Niemeyer, T. Ortlepp, H. Rogalla, T. Schurig, M. Siegel, R. Stolz, E. Tarte, H.J.M. ter Brake, H. Toepfer, J.C. Villegier, A.M. Zagoskin, and A.B. Zorin, (2010) European roadmap on superconductive electronics - status and perspectives. Physica C: Superconductivity,. 470(23-24): p. 2079-2126. DOI: 10.1016/j.physc.2010.07.005

7.Frommhold, A. and E. Tarte, (2010) Electrochemical Interface Modification Through Large Area Surface Nanostructuring. Sensor Letters,. 8(3): p. 470-475. DOI: 10.1166/sl.2010.1296

8.Lacour, S.P., S. Benmerah, E. Tarte, J. FitzGerald, J. Serra, S. McMahon, J. Fawcett, O. Graudejus, Z. Yu, and B. Morrison, (2010) Flexible and stretchable micro-electrodes for in vitro and in vivo neural interfaces. Medical & Biological Engineering & Computing,. 48(10): p. 945-954. DOI: 10.1007/s11517-010-0644-8