

## Curriculum Vitae

Professor Sir Richard Friend, FRS, FREng  
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Date of Birth: 18th January 1953                      Nationality:      British

## Education

1971-4      Trinity College, Cambridge  
              BA in Theoretical Physics, Class 1, 1974

1974-8      Research Student in the Cavendish Laboratory, Cambridge, Ph.D 1979  
              Research Fellowship, St. John's College, from May 1977

## Current University Position

1995- Cavendish Professor of Physics, University of Cambridge  
1977- Fellow, St. John's College, Cambridge

## Other Employments/Consultancies

1996- Chief Scientist, Cambridge Display Technology Ltd.  
1998- Consultant, Epson Cambridge Laboratory  
2000- Chief Scientist and Director, Plastic Logic Ltd.  
2003 Mary Shepard B Upson Visiting Professor, Cornell University, USA

## Previous Employment

1977-1980    Research Fellow, St. John's College, Cambridge

[March 1977 -      March 1978. Attaché de Recherche du CNRS, at the Laboratoire de Physique  
des Solides, Université Paris-Sud, Orsay, France]

1980-1985    University Demonstrator in Physics, University of Cambridge  
1985-1993    University Lecturer in Physics, University of Cambridge  
1993-1995    University Reader in Experimental Physics,, University of Cambridge

[July 1986 - Jan. 1987, Visiting Professor at the University of California, Santa Barbara.  
March - July 1987, Chercheur Associé au CNRS, Centre de Recherche sur les Très  
Basses Températures, Grenoble, France  
Oct. 1992- Oct. 1993    Nuffield Foundation Science Research Fellowship]

1980-1995    Teaching Fellow, St. John's College, Cambridge  
              1984-86 Director of Studies in Physics, 1987-91 Tutor

1998-2003    Member, Technology Advisory Council, BP plc

## **Prizes, etc.**

- 1988 Charles Vernon Boys Prize of the Institute of Physics
- 1991 Royal Society of Chemistry Interdisciplinary Award
- 1993 Fellow of Royal Society of London
- 1994 Mott Lecture, Condensed Matter and Materials Physics Division of the Institute of Physics
- 1996 Hewlett-Packard Prize of the European Physical Society
- 1998 Rumford Medal of the Royal Society of London
- 2000 Honorary Doctorate, University of Linköping, Sweden
- 2001 Italgas prize for research and technological innovation
- 2002 Honorary Doctorate, University of Mons-Hainaut, Belgium
- 2002 Silver Medal, Royal Academy of Engineering, London
- 2002 McRobert Prize, Royal Academy of Engineering, London (awarded for engineering achievement by Cambridge Display Technology)
- 2002 Fellow, Royal Academy of Engineering
- 2003 Faraday Medal of the Institute of Electrical Engineers
- 2003 Gold Medal of the European Materials Research Society
- 2003 Knight Bachelor (Queen's birthday honours)
- 2003 Descartes Prize of the European Commission (coordinator of polymer LED project)
- 2004 Honorary Fellow of the Royal Society of Chemistry

## **Named Lectures**

- 1997 Debye Lecture, University of Utrecht, The Netherlands
- 1999 Rochester Lecturer, Department of Physics, University of Durham
- 1999 Rolf Sammet Visiting Professorship, University of Frankfurt-Main
- 1999 H. H. Johnson Lecturer, Cornell University
- 2000 A. D. Little Lecturer, MIT
- 2001 Xerox Distinguished Lecturer, Toronto
- 2001 Engineering Lecture, University College of North Wales, Bangor
- 2004 Kelvin Lecture of the Institution of Electrical Engineers

**Citations:** Identified by ISI as the most-cited UK-based scientist working in the physical sciences over the decade 1990-1999. Identified by ISI as one of the 2 most-cited physicists based in the UK

## **Research Interests**

I have pioneered the physics and engineering of semiconductor devices made with carbon-based semiconductors. I have shown that semiconductor polymers, such as poly(phenylene vinylene), can be processed to form high-performing semiconductor devices, and my research group was the first to demonstrate using polymers clean operation of field-effect transistors (1988), light-emitting diodes (1990), efficient photovoltaic diodes (1995), optically-pumped lasing (1996), and directly-printed polymer transistor circuits (2000).

This work has revolutionized the understanding of the electronic properties of molecular semiconductors, which are now recognized to be very suitable for use in semiconductor devices. It has also made possible new applications for semiconductors, particularly for solid-state light-emitting displays using polymer light-emitting diodes. Products based on these discoveries, in the form of cell phone displays, are now in the market. The impact of this technology may prove to be of immense significance: the fabrication of semiconductor devices and circuits by direct printing is radically different from the traditional patterning and process technologies of inorganic semiconductors, and will allow directly-printed semiconductor circuits to be manufactured at much lower cost. I have developed this work both within the University of Cambridge and also through the formation of two companies, Cambridge Display Technology and Plastic Logic.

## Publications:

>600 papers etc. in scientific journals

>20 patents (issued or pending)

### Highlights:

1. "Polymer Diodes and Transistors: New Semiconductor Device Physics", J. H. Burroughes, C. A. Jones and R. H. Friend, *Nature* **335**, 137-141 (1988).
2. "Light-Emitting Diodes Based on Conjugated Polymers", J. H. Burroughes, D. D. C. Bradley, A. R. Brown, R. N. Marks, K. Mackay, R. H. Friend, P. L. Burn and A. B. Holmes, *Nature* **347**, 539-541 (1990).
3. "Chemical Tuning of Electroluminescent Copolymers to Improve Emission Efficiencies and Allow Patterning", P. L. Burn, A. B. Holmes, A. Kraft, D. D. C. Bradley, A. R. Brown, R. H. Friend and R. W. Gymer, *Nature* **356**, 47-49 (1992).
4. "Efficient Polymer-Based Light-Emitting Diodes Based on Polymers with High Electron Affinities", N. C. Greenham, S. C. Moratti, D. D. C. Bradley, R. H. Friend and A. B. Holmes, *Nature* **365**, 628-630 (1993).
5. "Efficient Photodiodes From Interpenetrating Polymer Networks", J. J. M. Halls, C. A. Walsh, N. C. Greenham, E. A. Marseglia, R. H. Friend, S. C. Moratti and A. B. Holmes, *Nature* **376**, 498-500 (1995).
6. "Ferromagnetism and Intermolecular Interactions in  $\text{NH}_4\text{Ni}(\text{mnt})_2 \cdot \text{H}_2\text{O}$ ", A. T. Coomber, D. Beljonne, R. H. Friend, J. L. Brédas, A. Charlton, N. Robertson, A. E. Underhill, M. Kurmoo and P. Day, *Nature* **380**, 144-146 (1996).
7. "Lasing From Conjugated Polymer Microcavities", N. Tessler, G. J. Denton and R. H. Friend, *Nature* **382**, 695-697 (1996).
8. "Charge separation in localized and delocalized electronic states in polymeric semiconductors", A. Köhler, D. A. dos Santos, D. Beljonne, Z. Shuai, J. L. Brédas, A. Kraus, K. Müllen and R. H. Friend, *Nature* **392**, 903-906 (1998).
9. " $\text{Li}_{0.6}$ -15-crown-ether. $[\text{Ni}(\text{dmit})_2]_2 \cdot \text{H}_2\text{O}$ : A Molecular Metal with an Ion-Conducting Channel", T. Nakamura, T. Akutagawa, K. Honda, A. E. Underhill, A. T. Coomber and R. H. Friend, *Nature* **394**, 159-162 (1998).
10. "Integrated Optoelectronic Circuits Based on Conjugated Polymers", H. Sirringhaus, N. Tessler and R. H. Friend, *Science* **280**, 1741-1744 (1998).
11. "Laminated fabrication of polymeric photovoltaic diodes", M. Granström, K. Petritsch, A. C. Arias, A. Lux, M. R. Andersson and R. H. Friend, *Nature* **395**, 257-260 (1998).
12. "Electroluminescence in Conjugated Polymers", R. H. Friend, R. W. Gymer, A. B. Holmes, J. H. Burroughes, R. N. Marks, C. Taliani, D. D. C. Bradley, D. A. Dos Santos, J. L. Brédas, M. Lögdlund and W. R. Salaneck, *Nature* **397**, 121-127 (1999).
13. "All-Polymer Photonic Devices: Semiconducting Mirrors from  $\pi$ -Conjugated Polymers", P. K. H. Ho, D. S. Thomas, R. H. Friend and N. Tessler, *Science* **285**, 233-236 (1999).
14. "Two-Dimensional Charge Transport in Self-Organised, High-Mobility Conjugated Polymers", H. Sirringhaus, P. J. Brown, R. H. Friend, M. M. Nielsen, K. Bechgaard, B. M. W. Langeveld-Voss, A. J. H. Spiering, R. A. J. Janssen, E. W. Meijer, P. Herwig and D. M. de Leeuw, *Nature* **401**, 685-688 (1999).
15. "Molecular-scale interface engineering for polymer light-emitting diodes", P. K. H. Ho, J. S. Kim, J. H. Burroughes, H. Becker, S. F. Y. Li, T. M. Brown, F. Cacialli and R. H. Friend, *Nature* **404**, 481-484 (2000).

16. "High-Resolution Inkjet Printing of All-Polymer Transistor Circuits", H. Sirringhaus, T. Kawase, R. H. Friend, T. Shimoda, M. Inbasekaran, W. Wu and E. P. Woo, *Science* **290**, 2123-2136 (2000).
17. "Self-organized discotic liquid crystals for high efficiency organic photovoltaics," L. Schmidt-Mende, A. Fechtenkötter, K. Müllen et al., *Science* **293** (5532), 1119-1122 (2001).
18. "Spin-dependent exciton formation in pi-conjugated compounds," J. S. Wilson, A. S. Dhoot, A. J. A. B. Seeley et al., *Nature* **413**, 828-831 (2001).
19. "Self-Aligned, Vertical-Channel, Polymer Field-Effect Transistors", N. Stutzmann, R. H. Friend, and H. Sirringhaus, *Science* **299**, 1881-1884 (2003).