

## Professor Graham J. Hutchings

### A tribute



This special issue of Arkivoc is dedicated to Professor Graham Hutchings,  
on the occasion of his contribution to catalysis

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Graham Hutchings has had a remarkable and varied career in the field of catalysis, working both in industry and academia. His research has a broad scope, and he has made scholarly contributions to several catalysis-related fields and been a pioneer in a number of them. Novel approaches to catalyst preparation for both metal oxides and supported nanoparticles, selective oxidation, acetylene hydrochlorination, direct hydrogen peroxide synthesis, and his central role in the discovery, use, and understanding of gold-based catalysts are just a few examples of his notable contributions to the field. He has inspired many in the field by bringing heterogeneous catalysis to organic transformations through his extensive work and international collaborations.

Graham entered the field of heterogeneous catalysis in a fairly unusual way. He was hired by ICI to work on biological chemistry projects after earning his PhD in biological chemistry at University College London on *in vivo* ATP production. Nevertheless, these initiatives were abandoned before he even began working there, and if he wanted to stay with the company, he had to consent to switching to projects involving heterogeneous catalysis. He spent nine years working for ICI in managerial roles in research, production, and production support in the UK before being seconded to ICI South Africa in 1981, where he eventually rose to the post of Chief Research Officer.

In 1984, Graham made the decision to leave his career in industry and joined the faculty of the University of the Witwatersrand's Department of Chemistry. He rapidly started to make a name for himself in the academic community. In his early academic work, he concentrated on Fischer-Tropsch chemistry and also engaged in the use of zeolites to convert methanol to hydrocarbons, publishing many important contributions on this topic. He also continued his great interest in the selective oxidation of butane to maleic anhydride using vanadium phosphate catalysts, which originated from his days with ICI. His work focused on mechanistic understanding of these surface catalysed organic processes, and this approach continues as a central theme throughout his research.

In 1987 Graham departed South Africa and joined Liverpool University's Leverhulme Center for Innovative Catalysis. His prolific scholarly publications solidified his position as a leader in his field of heterogeneous catalysis, and saw emergence of new areas of research, such as enantioselective catalysis. Graham served as Cardiff University's Head of Chemistry from 1997 to 2006, during which time he accepted the Chair of Physical Chemistry and established the department's research group in heterogeneous catalysis, the largest research group, which it still has today. Graham served as the director of the Cardiff Catalysis Institute (CCI) from its founding in 2008 until 2019. The CCI established an international reputation for catalysis research under his leadership.

Graham's initial research in industry focussed on the oxidation of butane to maleic anhydride and this kick-started his interest in selective oxidation catalysis. It was in industry that he predicted that gold would be the best catalyst for the hydrochlorination of acetylene to make vinyl chloride, the monomer for the production of PVC. He subsequently showed that the prediction was correct, and this led to a gold catalyst being commercialised by Johnson Matthey for vinyl chloride production in China. He has pioneered the use of gold and gold-palladium alloys as catalysts for the selective oxidation of alcohols and the epoxidation of alkenes. Recently he has led the use of *in situ* production of hydrogen peroxide coupled with an oxidation catalyst such as an enzyme, to give improved catalysts for the selective oxidation of hydrocarbons to alcohols and the synthesis of oximes. He has published over 950 papers and patents and his highly cited work has greatly influenced the field of catalysis, especially the application to organic reactions.

Graham has received many honours over his career, most notably being elected a Fellow of the Royal Society in 2009, being named Regius Professor of Chemistry at Cardiff in 2016 (which was the inaugural Regius

Chair in Wales), and becoming a Commander of the British Empire (CBE) in the 2018 Queen's Birthday Honours.

## Short CV

Regius Professor Graham John Hutchings CBE FRS

ORCID ID: [orcid.org/0000-0001-8885-1560](https://orcid.org/0000-0001-8885-1560) Date of birth: 3rd February 1951

URL: <http://www.cardiff.ac.uk/chemy/contactsandpeople/academicstaff/hutchings.html>

Education 1972 BSc in Chemistry with First Class Honours, University College London; 1975 PhD in Biological Chemistry, University College London. Supervisor: Prof C Vernon; 2002 DSc (University of London)

Summary of career and employment Graham Hutchings is distinguished for his work in the field of heterogeneous catalysis, in particular catalysis by gold and oxidation catalysis. Hutchings has not followed the standard academic career profile rather following a PhD in biological chemistry on *in vivo* ATP synthesis, he was recruited by ICI for a biological chemistry project, but they scrapped the research before he joined the company, and so switched fields to heterogeneous catalysis to remain with ICI. He stayed with ICI for 9 years in mainly research, production, and production support managerial posts – he was carbonylation plant manager at one stage in 1980-81 responsible for production valued at the time in excess of £100M. He became an academic in 1984 and has established himself as an internationally leading researcher in heterogeneous catalysis, particularly in catalyst discovery. He has held 3 academic chairs (Witwatersrand, Liverpool, Cardiff) and for each he has reshaped his research, attacked new fields and has a proven track record in opening-up new fields of heterogeneous catalysis using multidisciplinary approaches. His research is based on fundamental science of catalyst discovery which is then translated into application. His most significant discovery concerns catalysis by gold and a gold catalyst based on his discovery has recently been commercialised in China by Johnson Matthey, thereby eradicating the use of mercury. His current EPSRC grant holding: £9.1M(PI)+£10.3M(Col).

His career history is as follows:

- 1975– 1984 ICI Petrochemicals Division, Technical Officer 75-79, Production Support and Plant Manager 79-81 ; AECI Ltd S Africa Research and Production Support 81-84.
- 1984– 1987 University of Witwatersrand, S Africa; promoted Professor 1987
- 1987– 1997 University of Liverpool; Professor 1994
- 1997 – 2019 Cardiff University; Professor of Physical Chemistry, HoS from 1997 - 2009
- 2010 – 2012 Cardiff University; PVCRC
- 2008 – 2019 Cardiff University; Director Cardiff Catalysis Institute
- 2016 – to date Cardiff University; Regius Professor of Chemistry

Awards and distinctions Langmuir Distinguished Lecturer Award, ACS, 1996; DGMK 2001 – Kolleg Lectureship, Germany, 2001; IChemE Entech Medal 2004; RSC 2004 Award for Heterogeneous Catalysis; 2005 François Gault Lecturer of the European Federation of Catalysis Societies; I Chem E Impact Award for Applied Catalysis 2005; RSC Green Chemistry Lecturer 2007; IChemE Environwise Award for Green Chemistry 2007; Winner Dow Methane Challenge 2008; Elected Fellow of the Royal Society 2009; RSC Award for Surfaces and Interfaces 2009; I Chem E Sustainability Award 2009; Elected member Academia Europaea September 2010; Elected Founding Fellow Learned Society of Wales; IPMI Henry J. Albert Award 2011; France Great Britain

Chemistry Prize 2011; Dechema Alvin Mittasch Award 2012; International Association of Catalysis Societies Heinz Heinemann Award 2012; Thompson Reuters Citation Laureate September 2012; Distinguished Visiting Lecturer, Catalysis Society of South Africa, 2013; Royal Society Davy Medal 2013; Dewar Lectureship, Queen Mary College, London; Thompson Reuters Most Cited Scientist Award 2014; Xingda Lecturer University of Peking 2015; IChemE Global Innovative Product Award 2015; Cardiff University international Impact Award 2016; Learned Society of Wales Menelaus Medal 2017; RSC Industry Academia Collaboration Award 2017; Eni Award for Advanced Environmental Solutions, 2017; Outstanding Contribution to Oxidation Catalysis Award 8<sup>th</sup> WCOC, Krakow 2017; Royal Society of Chemistry Faraday Lectureship Prize 2018; Appointed CBE in the Queen's Birthday Honours 2018; Zhang Dayu Lecture DICP, China 2018; Awarded 2019 Distinguished Scientist CAS President's International Fellowship Initiative (PIFI), NACS&EFCATS 2021 Michel Boudart Award.

External positions of note J. Catal. Editor 1999-2020; Senior Editor 2020-date; Editor Scientific Reports (Nature) 2014-2020; Editor Gold Bulletin 2015-date; Member of 15 Journal Editorial Boards; Treasurer and Committee Member International Association of Catalysis Societies 2000-2008; Member of the Fachbeirat of the Fritz-Haber Institute 1999-2015; & MPI Coal Conversion Mulheim 2012-14; Member of Sasol Heterogeneous Catalysis Advisory Board 2000-2009; Member of NIOK International Review Group 2000, 2006, 2010 (Chair), member review team for Chemical Engineering in the Netherlands 2015; Invited Professor in Residence at the Université Pierre et Marie Curie, Paris, 2003-4; UK RAE panel member for Chemistry (Panel 18) 2005-2008; Chair of Science Communities Representing Science Communities 2010-2013; Visiting Professor Tokyo Metropolitan University 2010-date; Adjunct Professor Louisiana State University 2011-date; UK REF Panel Deputy Chair for Chemistry (Panel B8) 2011-14; President Faraday Division RSC 2012-15; Director UK Catalysis Hub 2013-15 and Director 2017-18; Head of the Chemistry Section. Academia Europaea 2016-2022.

Publications 953 publications (800 refereed journal research papers; 54 Patents; 78 Review articles; 21 Edited works, over 63400 citations (Google Scholar 17.03.23), h-index 116, over 250 research lecture presentations worldwide.

Stuart H. Taylor  
Cardiff University  
UK

Christopher J. Kiely  
Lehigh University  
USA

## Selected Important Papers

1. G.J. Hutchings, 'Vapour phase hydrochlorination of acetylene: Correlation of catalytic activity of supported metal chloride catalysts', *J. Catal.*, 96 (1985) 292-295.  
[https://doi.org/10.1016/0021-9517\(85\)90383-5](https://doi.org/10.1016/0021-9517(85)90383-5)
2. M.D. Hughes, Y.-J. Xu, P. Jenkins, P. McMorn, P. Landon, D.I. Enache, A.F. Carley, G.A. Attard, G.J. Hutchings, F. King, E.H. Stitt, P. Johnston, K. Griffin, and C.J. Kiely, "Tunable gold catalysts for selective hydrocarbon oxidation under mild conditions", *Nature* 437 (2005) 1132-1135.  
<https://doi.org/10.1038/nature04190>
3. D.I. Enache, J. K. Edwards, P. Landon, B. Solsona-Espriu, A. F. Carley, A. A. Herzing, M. Watanabe, C. J. Kiely, D. W. Knight, and G. J. Hutchings, "Solvent-free oxidation of primary alcohols to aldehydes using titania-supported gold-palladium catalysts", *Science*, 311 (2006) 362-365.  
<https://doi.org/10.1126/science.1120560>

4. L. Kesavan, R. Tiruvalam, M.H. Ab Rahim, M.I. bin Saiman, D.I. Enache, R. L. Jenkins, N. Dimitratos, J.A. Lopez-Sanchez, S.H. Taylor, D.W. Knight, C.J. Kiely, G.J. Hutchings "Solvent-Free Oxidation of Primary Carbon-Hydrogen Bonds in Toluene Using Au-Pd Alloy Nanoparticles" *Science* 331 (2011) 195-199.  
<https://doi.org/10.1126/science.1198458>
5. G. Malta, S.A. Kondrat, S.J. Freakley, C.J. Davies, L. Lu, S. Dawson, A. Thetford, E.K. Gibson, D.J. Morgan, W. Jones, P.P. Wells, P. Johnston, C.R.A. Catlow, C.J. Kiely and G.J. Hutchings "Identification of single-site gold catalysts in acetylene hydrochlorination" *Science* 355 (2017) 1399-1402.  
<https://doi.org/10.1126/science.aal3439>
6. X. Huang, O. Akdim, M. Douthwaite, K. Wang, L. Zhao, R.J. Lewis, S. Patisson, I.T. Daniel, P.J. Miedziak, G. Shaw, D.J. Morgan, S.M. Althabhan, T.E. Davies, Q. He, F. Wang, J. Fu, D. Bethell, S. McIntosh, C. J. Kiely, and G.J. Hutchings 'Au-Pd separation enhances bimetallic catalysis of alcohol oxidation' *Nature* 603 (2022) 271-275.  
<https://doi.org/10.1038/s41586-022-04397-7>
7. R.J. Lewis, K. Ueura, X. Liu, Y. Fukuta, T.E. Davies, D.J. Morgan, L. Chen, J. Qi, J. Singleton, J.K. Edwards, S.J. Freakley, C.J. Kiely, Y. Yamamoto, and G.J. Hutchings 'Highly efficient catalytic production of oximes from ketones using in situ-generated H<sub>2</sub>O<sub>2</sub>' *Science* 376 (2022) 615-620.  
<https://doi.org/10.1126/science.abl4822>

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