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In Memoriam ...

Digby D. Macdonald

(1943–2025)

Digby Macdonald passed away on June 11, 2025, at the age of 81. A native New Zealander, Digby earned his BSc and MSc in Chemistry from the University of Aukland, New Zealand, and his PhD in Chemistry from the University of Calgary in Canada. He held several positions in his career, starting as Assistant Research Officer at the Whiteshell Nuclear Research Establishment, Atomic Energy of Canada Ltd., from 1969 to 1972. He was at SRI International, Menlo Park, California, from 1984 to 1991 and 1998 to 1999. Digby's academic positions included Lecturer in Chemistry, Victoria University of Wellington, New Zealand, from 1972 to 1975, Professor of Materials Science and Engineering and Director of the Fontana Corrosion Center at The Ohio State University from 1979 to 1984, and Professor of Materials Science and Engineering at The Pennsylvania State University from 1991 to 2012, where he retired as an emeritus professor. His final appointment was as Professor in Residence, Departments of Nuclear Engineering and Materials Science and Engineering, University of California, Berkeley.

Digby published more than 600 papers and received many awards for his work, including the following awards from ECS: Carl Wagner Memorial Award in 1991, Fellow of The Electrochemical Society in 1995, Corrosion Division H. H. Uhlig Award in 2001, and the Olin Palladium Award in 2015. Other awards include the W. B. Lewis Memorial Lecture by Atomic Energy of Canada Limited in 1993, recognizing his pivotal contributions to the development of nuclear power; the U. R. Evans Award, the highest honor in corrosion science from the UK's Institute of Corrosion, in 2003; the Faraday Memorial Trust Gold Medal from the Michael Faraday Memorial Private Trust in 2012; the Gibbs Award from the International Association for the Properties of Water and Steam in 2013; the 2014 Frumkin Memorial Medal from the International Society of Electrochemistry; the Ad Augusta Award from the Auckland Grammar School; the Khwarizmi Laureate in Fundamental Science from Iran; Docteur Honoris Causa-INSA Lyon; and De Tao Master from China. In addition to ECS, he was also a fellow of the Royal Society of Chemistry, the Royal Society of New Zealand, NACE-International, and ASM International.

In 1981, while at Ohio State University, he published two papers in the *Journal of The Electrochemical Society* with his graduate students C. Y. Chao and L.-F. Lin, laying out the foundations of the point defect model (PDM) for which Digby is best known. He went on to publish 154 more papers on the PDM, including another paper in JES in 1992 that has garnered almost 1400 citations. The first 1981 paper, with Chao as the lead author, described the PDM and applied it to passivity and passive film growth. A search of Web of Science indicates over 1000 papers with the topic of "point defect model." The PDM applies Kroger-Vink terminology and the approaches of high temperature oxidation to passive film formation. Digby always argued that the high field model, which is commonly used to describe passive film growth, did not apply because a high field would cause dielectric breakdown of the thin passive film. In his view, the passive film field strength verged on but did not exceed the conditions for dielectric breakdown. Therefore, he could apply linear transport equations for cation vacancies. By setting up the reactions at the film/metal and film/electrolyte interfaces and assuming that the potential drop at the film/solution interface was linearly dependent on potential and pH but independent of film thickness, the PDM predicts direct logarithmic film growth. This represented a significant advance because the high field model predicts inverse logarithmic film growth, whereas experimental data align better with direct logarithmic film growth.

The second 1992 paper with L.-F. Lin as the first author addresses passive film breakdown. It is assumed that a void will form at the metal/film interface if the rate of hole production from the arrival of cation vacancies exceeds the rate of submergence of vacancies into the metal bulk, and when the void reaches a critical size, the passive film will collapse locally, forming a pit. The filling of anion vacancies at the film/solution interface by chloride ions leads to an increase in cation vacancy concentration and thus cation vacancy flux across the film, thereby promoting film breakdown.