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CAMBRIDGE SOCIETY FOR THE APPLICATION OF RESEARCH

The Making of Reactive Metals

Professor Derek Fray FREng
Dept of Materials Science and Metallurgy,University of Cambridge

Monday 25th November, 2002: ***7.30 p.m. - 9.00 p.m***
The Wolfson Lecture Theatre, Churchill College, Cambridge

Chair: Professor Alan Windle

Professor Fray writes:

"Titanium is a the fourth most abundant metal in the earth's crust and has some excellent properties such as high strength, low density and high resistance to oxidation and corrosion. Titanium is used in aircraft engines and the airframe, chemical plant and in medical prostheses. However, it has one major disadvantage; its cost, which prevents its much wider use.

The high cost is due partly to its method of preparation that entails carbo-chlorination, fractional distillation to obtain pure titanium tetrachloride, the reduction of the titanium tetrachloride by magnesium and the regeneration of the magnesium and chlorine by the electrolysis. The down stream processing costs are also very expensive.

At Cambridge, we have developed a completely novel method of reducing metal oxides, including titanium dioxide. An oxide compact is made the cathode in a bath of molten calcium chloride and on the application of a cathodic potential to the oxide, the favoured reaction is the ionisation of the oxygen and not the deposition of calcium. This is termed electro-deoxidation and is a much simpler and more elegant process than the present method in that the products are just the metal product and oxygen.

One other very surprising benefit of this process is that by simply mixing oxides together and performing electro-deoxidation, alloys are formed and this offers the possibility of obtaining homogeneous alloys that cannot be made at the present time.

Overall, the process as well as reducing the cost of the initial reduction step also offers the possibility of reducing some of the downstream processing steps and, hopefully, this will greatly reduce the cost of titanium and other metal products.

Finally, the exploitation of this exciting technology will be discussed."

About the Speaker

Derek Fray is Professor of Materials chemistry and Head of Department, Department of Materials Science and Metallurgy, University of Cambridge. He is a Fellow of the Institution of Materials, Minerals and Mining and a member of the American Institute of Metallurgical engineers. He has published over 280 articles on materials processing and one book and is cited as the inventor on over 120 published patents.

Twelve projects are now under active industrial development both in the U.K. and Europe, Australia and the United States. He has been awarded the following honours: Matthew Prize, AIME Extractive Metallurgy Technology Award, Sir George Beilby Medal, Kroll Medal, Fellow of the Royal Academy of Engineering, John Phillips Medal, Honorary Professor at the University of Science and Technology, Beijing, Visiting Professor, University of Leeds, Minerals, Metals & Materials Society's 2000 Extraction and Processing Distinguished Lecture Award, Billion Medal, 2001 Light Metals Reactive Metals Award and a Gold Medal by the Institute of Industrial Science, University of Tokyo.

He is a founder director of Ion Science Ltd., Ion Science Messtechnik Gmbh., Ion Science (Americas) llc., Environmental Monitoring and Control Ltd., Cambridge Advanced Materials Ltd., FFC Ltd and British Titanium plc. All these companies are exploiting technology developed by Derek Fray.

About the Subject (Richard Freeman writes)

My first hands-on encounter with titanium was during my PhD years; in those days, the only way you could isolate DNA in a usable state was by dye-buoyant centrifugation. You used an ultracentrifuge to apply at least 100,000g for a continuous 48 hours to a solution of caesium chloride. A density gradient would develop, heavier at the bottom of the tube than at the top. You then located your DNA using UV light, and carefully punctured the wall of the tube with a needle to extract it. You then had to get rid of the caesium chloride, which you did by dialyses.

The only material which could cope with this sort of treatment was (and still is) titanium. Our rotors cost a fortune, and you had to fight the American military for them – they wanted to use the metal for their latest toys.

Strangely, when our rotors were pensioned off (through metal fatigue) we used to use them for door stops, instead of sending them back to be melted down and re-used. Perhaps they were far too radioactive to be of use elsewhere?

Well, thanks to Derek Fray, titanium should become cheap enough for, err, *saucepans*?!
(Seriously, it's better than stainless steel for chemical reactors)

Richard Freeman
CSAR Organising Secretary