Chemical Bath Deposition and Electrodeposition of chalcogenide and oxide thin films for advanced photovoltaics applications

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Deposition of thin films from solutions is a very ancient science, starting with the electroless deposition of noble metals like gold and silver and extending progressively in the modern period to many metals and metallic alloys, like nickel or copper for electronic and protective applications. Electrodeposition arised from the 19th century with the discovery of electrochemistry with extending progressively the deposition to an impressive number of metals films for industrial applications. The deposition of semiconducting films for optoelectronic applications emerged much later at the middle of the 20th century with lead chalcogenide photodetectors but remained at a very low level since the onset of chemical bath deposition of CdS films in the 80's-90's for photovoltaic applications [1]. CBD is now an established technique for the deposition of buffer layers in CIGS solar solar module production at the GW level with both ZnS and CdS based films [2]. CBD is becoming more and more popular for other applications as for tin oxide passivation layers in perovskite solar cell research.

From a recipe oriented science, growth from solution appears more and more as an exceptional tool for low temperature, self organizing processes for interfacial growth control at the atomic level in optoelectronic devices. The presentation will recall the advent of buffer layer studies by solution growth for CIGS solar cells in the author's laboratory, from fundamental mechanistic and structural studies in the 90's to industrial processing. It will recall the seminal work of KL Chopra and his group in this field in the 80's. In a second part, the development of electrodeposition for semiconductor films with the advent of the electrodeposition of zinc oxide and CIGS will be highlighted [3,4].

It will be concluded about the importance of developing further the growth of thin films and devices from from chemical and electrochemical solution routes for large scale deployment of photovoltaics.

References :

1- « Innovation highway: Breakthrough milestones and key developments in chalcopyrite photovoltaics from a retrospective viewpoint », D. Abou-Ras, S. Wagner,B. Stanbery, H. Schock, R. Scheer, L. Stolt, S. Siebentritt, D. Lincot, C. Eberspacher, K. Kushiya, A. Tiwari
2- Book Chapter « Chemical deposition of chalcogenide thin films from solutions » by D. Lincot, M. Froment, H. Cachet in « Advances in electrochemical science and engineering » Vol. 6, Ed. R. Alkire, D.M. Kolb, 1999, Wiley-VCH
3- "Solution growth of functional zinc oxide films and nanostructures", D. Lincot, D., MRS BULLETIN 35(2010) 778-789
4- Book Chapter « From the lab to scaling up thin films for solar absorbers » by H. Deligianni, L.T. Romankiw, D. Lincot, P.P. Grand, in 'Electrochemical Engineering : the path from discovery to product », Ed. R. Alkire, P. Bartlett, M. T. Koper, 2019, Wiley-VCH Berlin

Curriculum Vitae

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Daniel Lincot graduated from the french engineering School ESPCI-Paristech. He started his research in the field of Photovoltaics in 1978, at the laboratoiry of solid state physics at CNRS. After his PhD he is engaged in 1980 at CNRS, at Chimie Paristech, in the field of semiconductor photelectrochemistry. He became strongly involved in the development of cadmium telluride (CdTe) and copper indium gallium diselenide (CIGS) thin film solar cells. In 2005 he created with the company EDF the Institute on R&D for Photovoltaics, IRDEP. In 2009 of a spin off company NEXCIS was created for the industrialization of low cost electrodeposited CIGS solar cells. He was general Chairman in 2008 of the 23rd European Photovoltaic Solar Energy Conference in Valencia. In 2010 he became Director of the French Federation of Research on Photovoltaics. He received the Silver Medal of CNRS in 2004, in 2011 the Charles Eichner Prize of the French Society of Metallurgy and Materials (SF2M) for his achievments in materials for energy, and in 2013 the prize of the Electrochemical Society of the Electrodeposition Division. In 2013 he became Scientific Director of the Institut Photovoltaïque d'Ile de France (IPVF) which is a private public institute for the Energy Transition created by the french governement.. In 2015, he received the grand price Pierre Süe of the French Society in Chemistry. In 2020, he received the Ivan Peyches price from the french Academy of Sciences for the applications of sciences to industry, and in 2021-2022 the Liliane Bettencourt's professor ship annual chair at Collège de France for technological innovation. He has published more than 300 papers, given about 200 invited conférences, and deposited various patents.