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Letter to the Editor

Comment on "Fabrication methods for low-Pt-loading electrocatalysts in proton exchange membrane fuel cell systems" [J.-H. Wee, K.-Y. Lee, S.H. Kim, J. Power Sources 165 (2007) 667–677]

Abstract

Glow discharge sputter deposition of metals like Pt or other materials is around for decades. One of the many advantages of this process is – certain prerequisites given – the good adhesion of the sputtered layers due to the physical assisted deposition.

Sputter deposition is attributed poor adherence by Wee et al. [Jung-Ho Wee, Kwan-Young Lee, Sung Hyun Kim, J. Power Sources 165 (2007) 667–677], which asks for some comments.

Keywords: Sputter deposition; Platinum catalyst; Adherence; Adhesion

Wee et al. [1] state in their review article that a drawback of sputter deposition is the poor adherence of Pt to the substrate and that the method is well recognized to be of poor durability. Obviously that conclusion was drawn from a recent publication by Saha et al. [2]. There it is said that in most cases the deposition has relatively poor adherence to the substrate and under variable conditions of load and temperature, there is a greater probability of dissolution and sintering of the deposits. However, no data or reference is given as to where this information was gained.

Sputter-deposited layers are formed by the ion bombardment of a target material. Material from that target is liberated from the bombarded surface and condenses as a film. As generally not the complete energy of the bombarding ions is used up to release atoms from the target, the atoms building up the film impact with kinetic energy from the bombardment. This leads to a generally good adhesion of the thin films as opposed to, for example, vacuum evaporation, where the thermal energy introduced in the evaporation process leads to a weaker adhesion of the deposited films.

Additionally, weakly bond atoms of the newly sputter-deposited films are resputtered by more energetic atoms, and thus a well adhesive layer is self-sustained in the process. Of course, all this is just a short and narrow extract of the physics and complex plasma process involved. It can be found in length and more detail in textbooks, e.g. [3,4], and is also dependent on many other factors like the precondition of the substrate or the vacuum condition in the sputter deposition tool.

In the paper by Saha et al. [2] an ion-beam assisted deposition is presented. In this context, ion-beam assisted deposition is certainly (depending on the parameter range) of better adhesion than sputter deposition due to the nature of the even higher deposition energies (higher degree of implantation at higher energy). But it cannot be concluded from this that sputter deposition has poor adhesion per se. Furthermore, manifold influences (degas procedure, sputter-etch, or preconditioning of substrate, to name just a few) can impact the adhesion and vary with different substrates, procedures, conditions, and tools used and make a difference if they change.

Adhesion problems of sputter-deposited Pt catalyst to the substrate might be possible in certain (or even all) cases and the interesting issue is definitely worth to be investigated (e.g. long term durability experiments), but the authors or the provided reference lack the scientific information to effectively demonstrate it on a general scale. Hence, the possibility of adhesion problems should be only noted as such. The more so as the also cited work by O'Hayre et al. [5] presents qualitative studies indicating that thin sputtered platinum films adhere strongly. Thus it becomes challenging to show and is arguable to speak of poor adhesion of sputter deposition in general.

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D. Gruber
Department of Micro Systems Technology, Hamburg University of Technology, D-21071 Hamburg, Germany
E-mail address: d.gruber@tuhh.de

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