

Platinum degradation model in the presence of oxygen

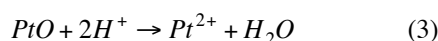
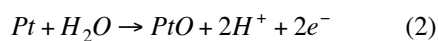
B. Jayasankar¹, D. Harvey³, K.Karan^{1,2}

¹Queen's-RMC Fuel Cell Research Centre, Queen's University, Kingston, Ontario, Canada

²The University of Calgary, Calgary, Canada

³Ballard power systems, Burnaby, Canada

Darling and Meyers [1] proposed the following mechanism to describe platinum degradation:



In the above mechanism, platinum is lost either through the direct anodic dissolution reaction (1) or through chemical dissolution reaction (3) of platinum oxide film formed through reaction (2). Both pathways of platinum degradation are oxide coverage dependent. In this model, the oxide coverage arises from water oxidation reaction (2). However in a fuel cell, in the presence of oxygen, surface oxides are also formed as reaction intermediates during oxygen reduction in addition to oxides from water oxidation. Therefore to study platinum degradation in the presence of oxygen, an updated model is required that can predict oxide coverage in the presence of oxygen. Further motivation to consider this issue comes from experimental observation of Matsumoto et al [3] that showed enhanced degradation of platinum in the presence of oxygen.

In this work Wang's multi step double trap mechanism [2] is used as a basis to develop a model that can predict surface oxide coverage in both the presence and absence of oxygen within the same framework as shown in figure 1. As shown in figure 2, the double trap kinetic mechanism can be used to track surface coverage of platinum as a function of potential while platinum degradation through anodic and chemical dissolution can occur simultaneously. Before the double trap kinetic mechanism can be utilized, it has to be modified to ensure it can capture water oxidation kinetics correctly.

In this work, the methodology to develop a platinum degradation model within an ORR kinetic framework is discussed.

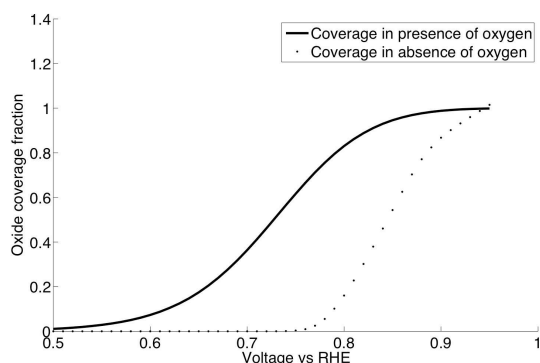


Figure 1: Surface oxide coverage in the presence and absence of oxygen

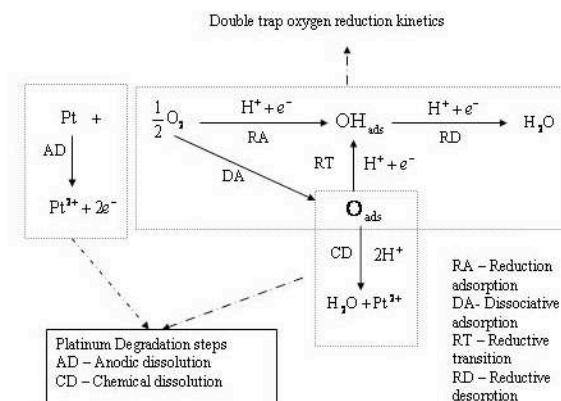


Figure 2: Platinum degradation framework

References

1. R.M. Darling and J.P. Meyers, J. Electrochemical Society, 2003, 150 (11), A1523-A1527
2. J.X. Wang, J. Zhang and R.R. Adzic J. Phys. Chem.A, 2007, 111 (49), 12702–12710
3. M. Matsumoto, T. Miyazaki and H. Imai J. Phys. Chem.C, 2011, 115 (22), 11163–11169