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**Date: March 8, 2016**
**Time: 11:30am**
**Location: Advanced Energy Center, Rm 104**

## *"Advanced Strategy for Nanoengineering of Platinum Monolayer Core-Shell Type of Fuel Cell Electrocatalysts"*

**By**
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According to the US Department of Energy (DOE), the cost, performance and durability of the polymer electrolyte membrane fuel cells (PEMFCs) are the main challenges that hinder their commercialization [1]. The largest portion of the cost of the fuel cell stacks (49%) is attributed to the large amount of Pt and platinum group metals (PGM) catalysts on the cathode side of the membrane electrode assemblies (MEAs). Increased Pt loading on the cathode is required because of the sluggish kinetics of the oxygen reduction reaction (ORR) [1,2]. In order to challenge the researchers all over the world, and to boost the implementation of the PEMFCs, DOE has set demanding technical targets for development of fuel cell electrocatalysts for transportation applications [1].

It has recently been demonstrated that Pt monolayer (ML) core-shell type of electrocatalysts are among the most promising candidates for the next generation PEMFCs. Their mass and specific activities, and as well as their durability performance, surpassed the DOE 2020 targets [3,4]. In this class of electrocatalysts, a surface limited redox replacement (SLRR) strategy is used in order to deposit a Pt ML shell on another transition metal (or alloy) nanoparticle core [3]. A pre-deposited Cu ML on respective nanoparticles at underpotentials (UPD) is galvanically displaced by Pt in a consecutive step, upon immersion of the sample in solution containing $Pt^{2+}$ ions. Thus, a full Pt utilization is achieved in the Pt ML core-shell type of electrocatalysts, and their excellent activity and performance stability has been demonstrated in either rotating disk electrode (RDE) or MEA studies [3-5]. Although, those catalysts showed outstanding performance, their reproducible synthesis in large scale is still challenging.

In this work we are reporting on novel fast and facile methodology for fabrication of PEMFC cathodes with ultra-low PGM loadings. We have designed and developed a semi-automated system for electrodeposition of Pt ML core-shell fuel cell electrocatalysts, utilizing the SLRR strategy, directly on the gas diffusion layer (GDL). The system is software controlled and allows fabrication of highly active and ddurable FC electrodes with geometric area of up to 500 $cm^2$ in a couple of hours, starting from raw materials (chemical salts, and commercial GDLs). As proposed elctrodeposition strategy allows for in-situ nanoengineering of the morphology, structure and composition of the nanostructured cores and ultra-precise control at sub-monolayer level of the Pt ML shell.

References

1. http://energy.gov/eere/fuelcells/downloads/fuel-cell-technologies-office-multi-year-research-development-and-22.
2. H.A. Gasteiger, S.S. Kocha, B. Sompalli and F. T. Wagner, *Applied Catalysis B-Environmental*, **56**, 9 (2005).
3. R.R. dzic, *Electrocatalysis*, **3**, 163 (2012).
4. K. Sasaki, H. Naohara, Y. Choi, Y. Cai, W.F. Chen, P. Liu and R.R. Adzic, *Nature Communications*, **3**, 1115 (2012).
5. R. Adzic, S. Bliznakov, and M. Vukmirovic, US Patent: Core-Shell Fuel Cell Electrodes, **US2015/0017565 A1**, Jan. 15, 2015.

*"Brief lunch will be provided during the talk"*

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