

Subject: MSD Colloquium, Stamenkovic, Thurs, 12/06, 11am, 212, A-157
From: Suzanne Kokosz <kokosz@anl.gov>
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To: Materials Science Division <msd@anl.gov>

MATERIALS SCIENCE COLLOQUIUM

SPEAKER: Vojislav Stamenkovic
Materials Science Division, ANL

TITLE: ³The Role of Surface Structure and Surface Composition in Electrocatalysis²

DATE: Thursday, December 06, 2007
TIME: 11:00 a.m.
PLACE: Building 212, Room A-157
HOST: John Schlueter

Refreshments will be available at 10:45 a.m

Abstract:

The important role of surface structure and composition in heterogeneous (solid-gas) catalysis has been known for decades from surface science studies in ultra high vacuum environments. However, in heterogeneous solid-liquid electrocatalysis that role has not been completely understood due to complexity of electrified interfaces.

More recently we managed reveal the mechanism of catalytic improvement from the knowledge obtained by surface characterization in ultra high vacuum and in-situ surface characterization of electrified solid-liquid interfaces. We have found that materials with unique surface properties can be created by alloying two or more metals [1]. Enhanced catalytic properties, considered at the atomic level scale, may occur through several effects: (1) Electronic effect, which refers to changes in physicochemical properties of the surface atoms due to altered electronic structure of the topmost atoms; (2) Strain effect that modifies the electronic properties via the tensile strain of the surface atoms; and (3) Structural effect, which includes correlation between surface atom arrangements, interatomic distances and bond tightness. These effects can dramatically change material properties and therefore the design of novel-advanced catalytically active materials should be performed at the atomic level scale.

Two representative examples will be presented for the oxygen reduction reaction: (1) polycrystalline surfaces of PtM (M = Ni, Co, Fe, V, Ti) alloys [2,3], and (2) single crystal surfaces of Pt₃Ni{hkl} [4] and Pt{hkl}. It has been found that Pt alloys with transition metals form nanosegregated surface profiles due to enrichment of platinum in the first atomic layer.

These surfaces can be produced regardless of the crystallographic orientation in the bulk. However, crystallographic orientation does have an important impact onto surface adsorption properties, and catalytic behavior. The most recent studies for cathodic fuel cell reaction revealed that nanosegregated surfaces with {111} crystallographic orientation have produced catalytic enhancement for factor of 90 vs. conventional state-of-the-art Pt-carbon catalyst and 10 times vs. corresponding pure Pt{111} surface.

These unique near surface formations would allow substantial decrease of the total platinum loading in fuel cell stacks and could improve durability of

fuel cells.

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References:

- [1] V.Stamenkovic, T.J.Schmidt, P.N.Ross, N.M.Markovic
Journal of Physical Chemistry B, 106(2002)11970-11979.
- [2] V.Stamenkovic, B.S.Mun, K.J.J.Mayrhofer, P.N.Ross,
N.M.Markovic, J.Rossmeisl, J.Greeley, J.K.Norskov
Angewandte Chemie Int. Ed., 45(2006)2897-2901.
- [3] V.R.Stamenkovic, B.S.Mun, M.Arenz, K.J.J.Mayrhofer,
C.A.Lucas, G.Wang, P.N.Ross, N.M.Markovic
Nature Materials, 6(2007)241-247.
- [4] V.R.Stamenkovic, B.Fowler, B.S.Mun, G.Wang, P.N.Ross,
C.A.Lucas, N.M.Markovic
Science, 315(2007)493-497.

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