Understanding electrochemical switchability of perovskite-type exsolution catalysts

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Precipitating metallic nanoparticles from perovskite-type oxides upon applying reducing conditions is a highly promising approach to obtain oxide-supported catalysts with exceptional properties. This process is often called exsolution. On mixed ionic/electronic conducting oxide electrodes the obtained catalyst particles can be electrochemically switched between different activity states, which is a particularly interesting property of these novel catalysts.

In this work, the exsolution and re-oxidation of iron particles on perovskite-type mixed conducting La$_{0.6}$Sr$_{0.4}$FeO$_{3-\delta}$ (LSF) electrodes was studied by synchrotron-based \textit{in-situ} X-ray photoelectron spectroscopy (XPS) and X-ray diffraction (XRD) at 625 °C in H$_2$/H$_2$O atmosphere. Upon cathodically polarizing the LSF electrodes – i.e. applying strongly reducing conditions – the formation of metallic $\alpha$-Fe particles could be observed on the LSF surface. This change of the electrode surface chemistry was accompanied by a strong improvement of its electro-catalytic activity. In contrast, application of sufficiently high anodic polarization – i.e. oxidizing conditions – the oxidation of $\alpha$-Fe to Fe$_{1-x}$O and Fe$_3$O$_4$ could be observed, accompanied by a drastic drop of the catalytic activity. This shows that re-integration of iron into the perovskite lattice is thus not required for obtaining a switchable catalyst. Rather, it is possible to reversibly switch between high and low activity state even though the exsolution process itself is irreversible.

To understand the origin of the high and low electro-catalytic activity, a mechanism is suggested which considers the different adsorption behavior of hydrogen on metallic iron and oxides. A consequence of this is that the presence of metallic iron particles establishes a novel reaction pathway that bypasses the rate limiting step on the bare oxide electrode surface, thus enabling the observed increase in electro-catalytic activity.
# DESY PHOTON SCIENCE USERS’ MEETING.

**25 - 29 January 2021 - Virtual Event**  
**DRAFT!**

## Time zone: CET Europe/Hamburg

### Monday, 25 January 2021  
Users’ Meeting 2021

| Time          | Session                                                                 |
|---------------|-------------------------------------------------------------------------|
| 11.00 – 13.00 | Tests etc.                                                              |

### Tuesday, 26 January 2021  
DESY Photon Science Users’ Meeting - FLASH

| Time          | Session                                                                 | Chair                                      |
|---------------|-------------------------------------------------------------------------|--------------------------------------------|
| 10.00 – 12.30 | Workshops etc.                                                          |                                            |

**Chair:**  
E. Plönjes/S. Toleikis

| Time          | Session                                                                 | Chair                                      |
|---------------|-------------------------------------------------------------------------|--------------------------------------------|
| 14.00 – 14.10 | Welcome - FLASH session                                                  | E. Weckert / M. Beye (DESY)                |
| 14.10 – 14.40 | Moving toward the new FLASH2020+ facility                               | E. Allaria (DESY)                          |
| 14.40 – 15.10 | FLASH new instrumentation                                                | R. Treusch (DESY)                          |
| 15.10 – 15.30 | Coffee break                                                            |                                            |

**Chair:**  
M. Beye/G. Brenner

| Time          | Session                                                                 | Chair                                      |
|---------------|-------------------------------------------------------------------------|--------------------------------------------|
| 15.30 – 16.00 | Single-shot temporal characterisation of XUV pulses@FLASH               | S. Düsterer (DESY)                         |
| 16.00 – 16.30 | Ultrafast probing of molecular dynamics at the sulfur L-edge            | M. Gühr (Univ. Potsdam)                    |
| 16.30 – 17.00 | Ultrafast Real-Time Dynamics of an Oxide Photocatalyst                  | H. Noei (DESY)                             |

### Wednesday, 27 January 2021  
Joint session European XFEL & DESY Photon Science Users’ Meeting - Soft X-ray FEL experiments

| Time          | Session                                                                 |
|---------------|-------------------------------------------------------------------------|
| 9.00 – 9.15   | Test - virtual poster session                                           |
| 9.15 – 11.00  | Scientific POSTER Session                                               |
| Time       | Session                                                                 | Chair                  |
|------------|-------------------------------------------------------------------------|------------------------|
| 11.00 – 11.10 | Welcome - Soft X-ray FEL session                                       | S. Pascarelli (EuXFEL) / E. Weckert (DESY) |
| 11.10 – 11.40 | Dissociation dynamics of small molecules (O₂, H₂O)                     | T. Jahnke (Univ. Frankfurt) |
| 11.40 – 12.10 | Observation of an Excitonic Mott Transition Through Ultrafast Core-cum-Conduction Photoemission Spectroscopy | M. Dendzik (KTH Stockholm, Sweden) |
| 12.10 – 12.40 | Direct visualization of spin-lattice coupling in FePt nanoparticles     | H. Dürr (Univ. Uppsala, Sweden) |
| 12.40 – 13.30 | Lunch break                                                            |                        |
| 13.30 – 19.00 | European XFEL Users’ Meeting 2021                                      |                        |

**Thursday, 28 January 2021**

**DESY Photon Science Users’ Meeting – PETRA III and PETRA IV**

| Time       | Session                                                                 | Chair                  |
|------------|-------------------------------------------------------------------------|------------------------|
| 9.45 – 10.00 | Test - virtual poster session                                           |                        |
| 10.00 – 12.00 | Scientific POSTER Session                                               |                        |
| 13.00 – 13.10 | Welcome - PETRA III session                                             | E. Weckert (DESY)      |
| 13.10 – 13.40 | Challenges in the design and construction of diffraction-limited synchrotron light sources | R. Bartolini (DESY)   |
| 13.40 – 14.10 | Experiments at PETRA IV: the route to the new beamline portfolio        | C. Schroer (DESY)      |
| 14.10 – 14.40 | Ptychographic X-ray Speckle Tracking                                    | A. Morgan (Univ. Melbourne, Australia) |
| 14.40 – 15.10 | Core–Shell Nanoparticle Interface and Wetting Properties                | E. Malmström (KTH Stockholm, Sweden) |
| 15.10 – 15.30 | Coffee break                                                           |                        |
| 15.30 – 16.00 | Understanding electrochemical switchability of perovskite-type exsolution catalysts | A. Opitz (TU Wien, Austria) |
| 16.00 – 16.30 | Superlattices of nanocluster and quantum dots: a playing field for exploiting structure-transport correlations | M. Scheele (Univ. Tübingen) |
### Functional supramolecular structures in infectious diseases mechanisms and therapy
**M. Landau** (CSSB/EMBL, Technion Haifa)

### Extreme conditions crystallography: the status and the challenges
**K. Glazyrin** (DESY)

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**Friday, 29 January 2021**

**DESY Photon Science Users’ Meeting 2021 – Future DESY**

**Chair:** M. Schnell/
K. Roßnagel

| Time     | Session                                                                 | Speaker                          |
|----------|--------------------------------------------------------------------------|----------------------------------|
| 9.00 – 9.15 | Welcome                                                                 | H. Dosch (DESY)                  |
| 9.15 – 9.45 | Overview DESY Photon Science                                              | E. Weckert (DESY)                |
| 9.45 – 10.10 | PETRA III and future outlook - PETRA IV                                   | C. Schroer (DESY)                |
| 10.10 – 10.30 | The PETRA IV Machine Project                                              | R. Bartolini (DESY)              |
| 10.30 – 11.00 | **Coffee break**                                                        |                                  |
| 11.00 – 11.30 | FLASH and future outlook – FLASH2020+                                     | M. Beye (DESY)                   |
| 11.30 – 12.00 | 3D virtual histology of lung and heart tissue affected by severe causes of Covid-19 | T. Salditt (Univ. Göttingen)     |
| 12.00 – 12.30 | Drug screening at PETRA III                                                | A. Meents (DESY)                 |
| 12.30 – 12.40 | Report of the ‘DESY Photon Science User Committee’ (DPS-UC)              | P. Müller-Buschbaum, *DPS-UC Chair* (TU München) |
| 12.40 – 12.50 | Report of the ‘Committee Research with Synchrotron Radiation’ (KFS)       | J.-D. Grunwaldt, *KFS Chair* (KIT Karlsruhe) |
| 12.50 – 13.00 | Report of the ‘European synchrotron and FEL user organisation’ (ESUO)     | U. Pietsch, *ESUO Chair* (Uni. Siegen) |

**Update:** 22 January 2021