ÚSTAV PŘÍSTROJOVÉ TECHNIKY
Akademie věd České republiky

Precizní analýza pokročilých nanomateriálů pomocí pomalých elektronů

Nízkonapěťová rastrovací (prozařovací) elektronová mikroskopie

Eliška Materna Mikmeková

Ilona Müllerová

- **Scanning Low Energy Electron Microscopy (SLEEM)**
- **Low Voltage Scanning Transmission Electron Microscopy (LV STEM)**

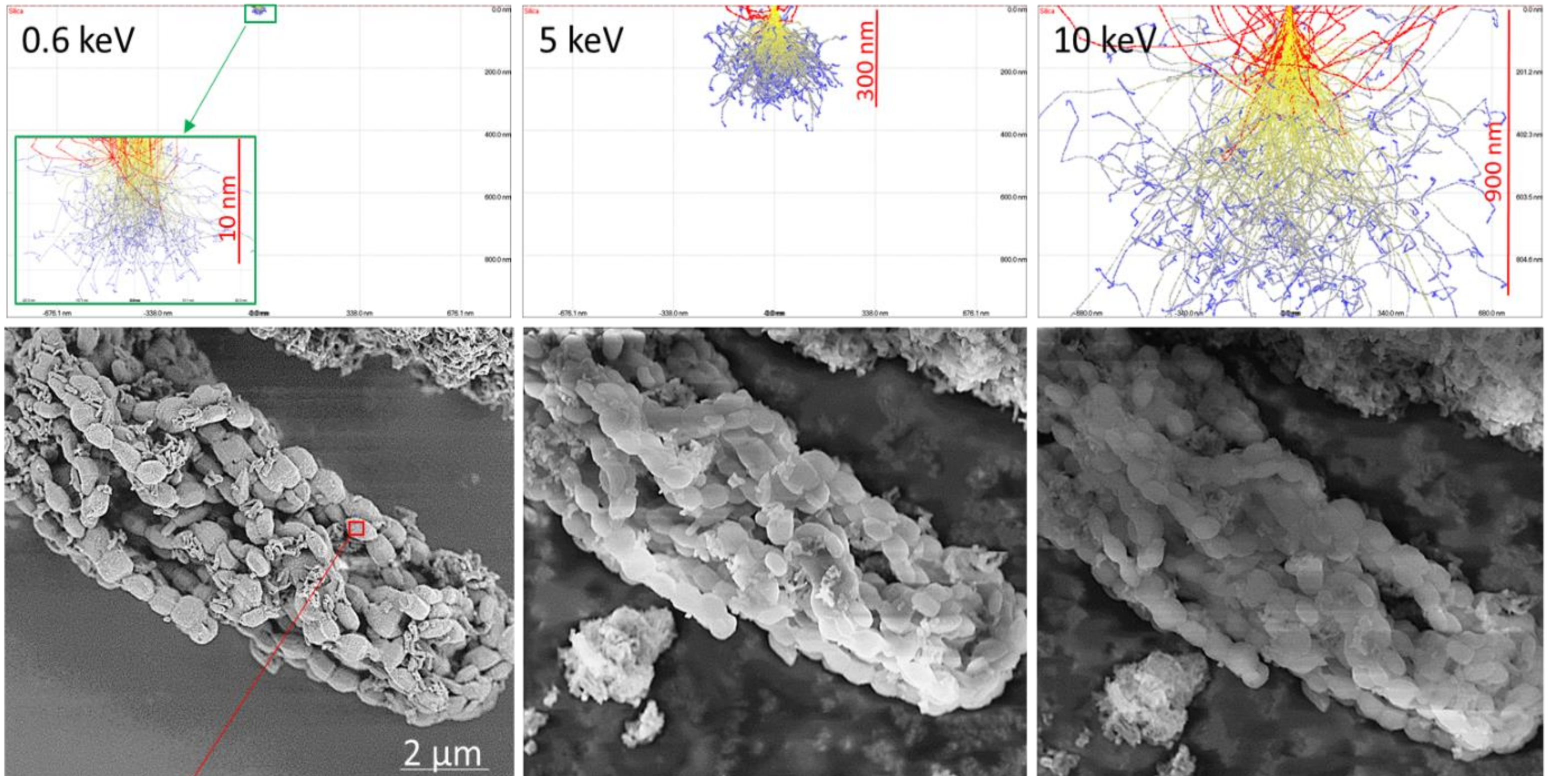
Výhody

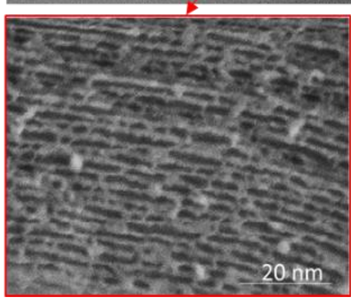
- Vysoká povrchová citlivost.
- Vysoký materiálových kontrast (např. zvýraznění nanočástic).
- Možnost studia nevodivých povrchů bez pokovení (pozorování v nativním stavu).
- Zachování vysokého rozlišení (pod 1 nm).

*(prezentováno na mezoporézní silice dopované Au nanočásticemi)**

Povrchová citlivost

Nižší dopadová energie elektronů = menší interakční objem = větší povrchová citlivost

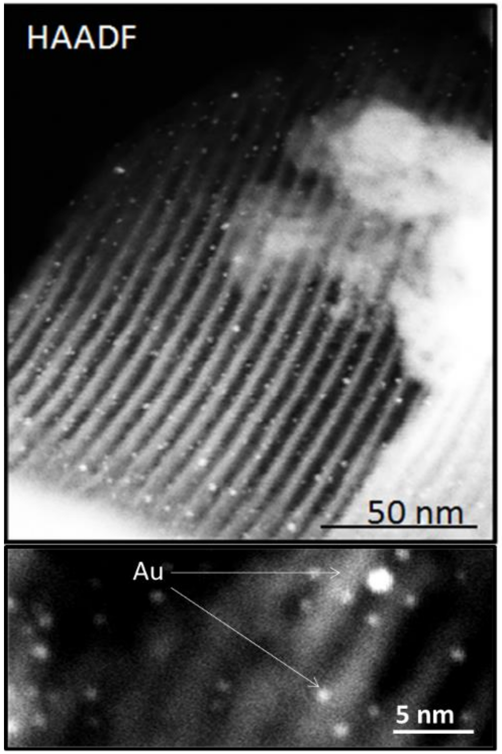


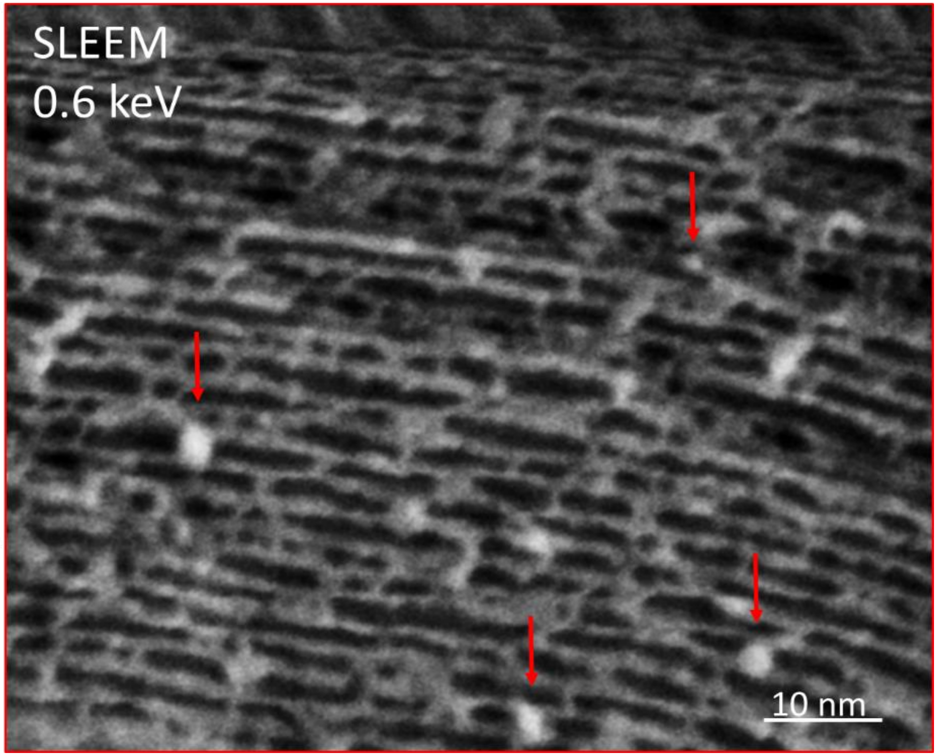


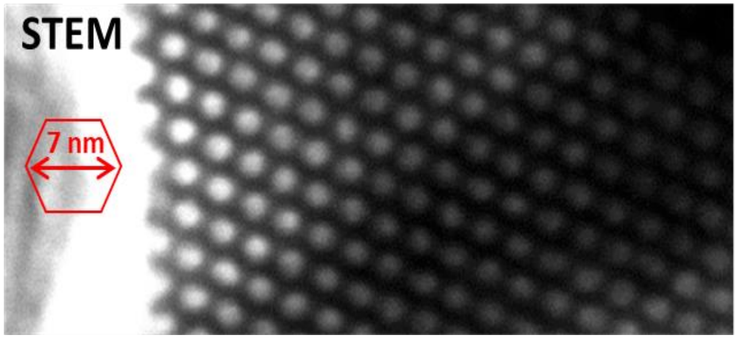
Energy (keV)	0.6	1	2	5	10	20	30
Interaction volume (nm)	10	20	55	300	900	2800	6000

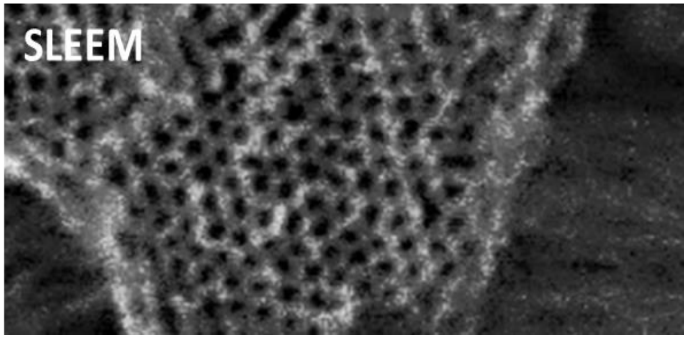
Materiálový kontrast a vysoké rozlišení

Nižší dopadová energie elektronů = lepší kontrast mezi nanočásticemi a strukturou + zachování vysokého rozlišení (0.6 nm STEM, 0.8 nm SLEEM).





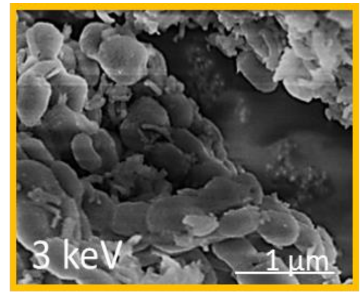


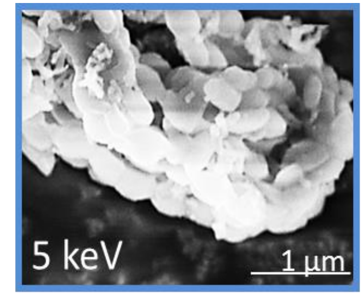


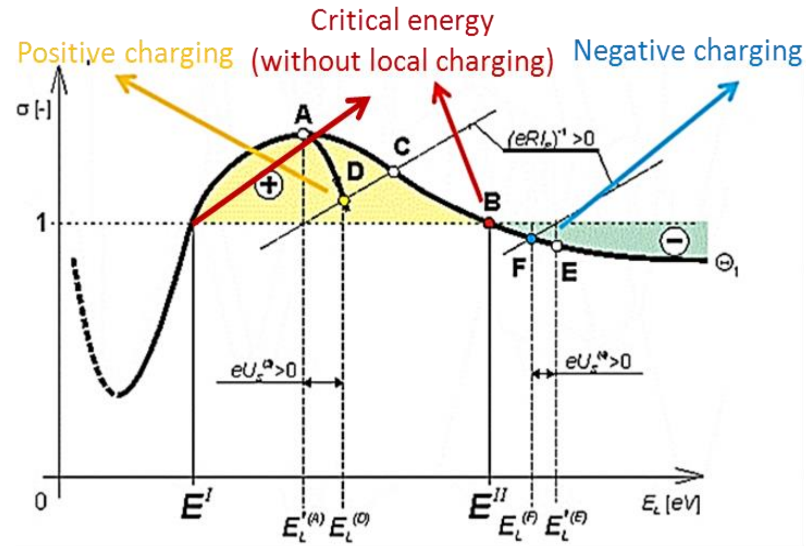
Studium nevodivých vzorků bez pokovení

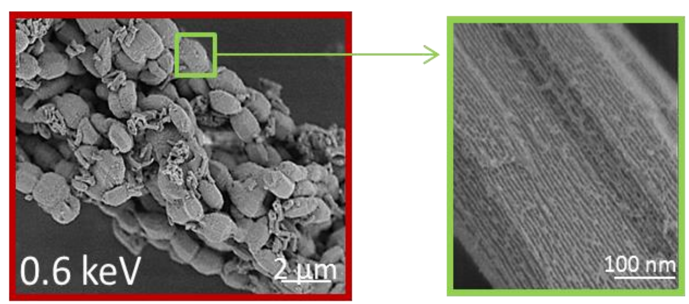
Zobrazení nevodivých preparátů při optimální energii elektronů nevyvolávající lokální nabíjení ani ve vysokém vakuu (tzv. kritická energie, kdy počet dopadajících elektronů se rovná počtu elektronů emitovaných ze vzorku).

Lze pozorovat nevodivé vzorky v nativním stavu, bez pokovení vodivou vrstvou, a takto předejít případné ztrátě detailů či dokonce poškození preparátu.



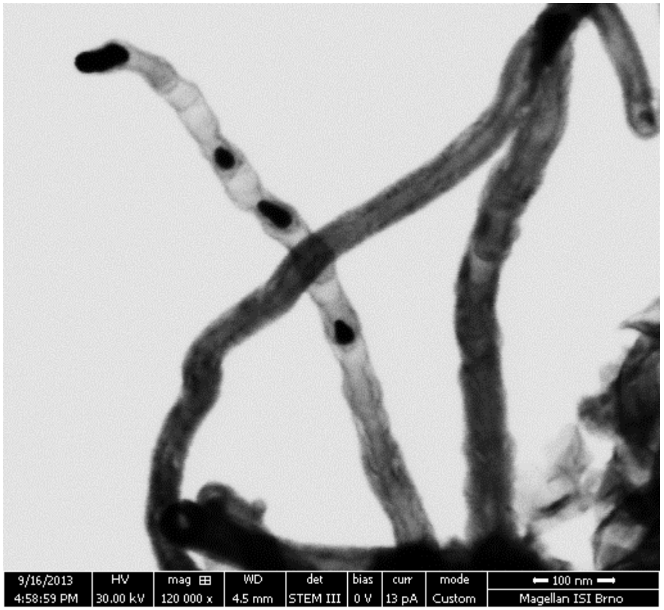


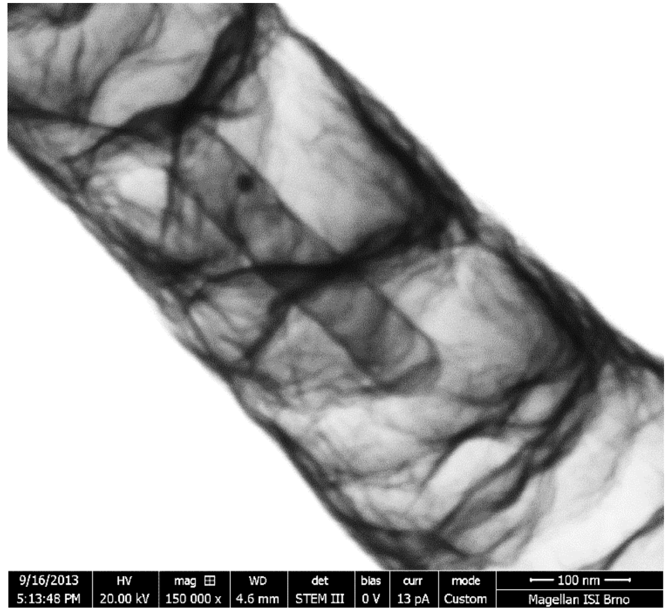


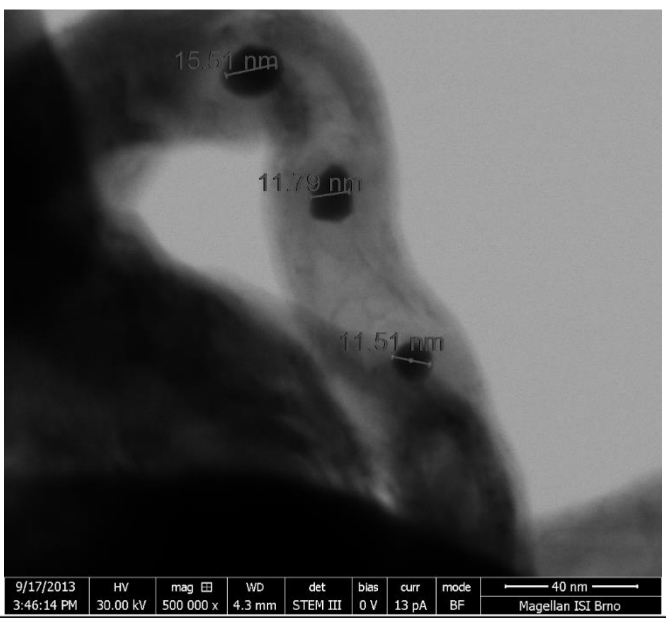


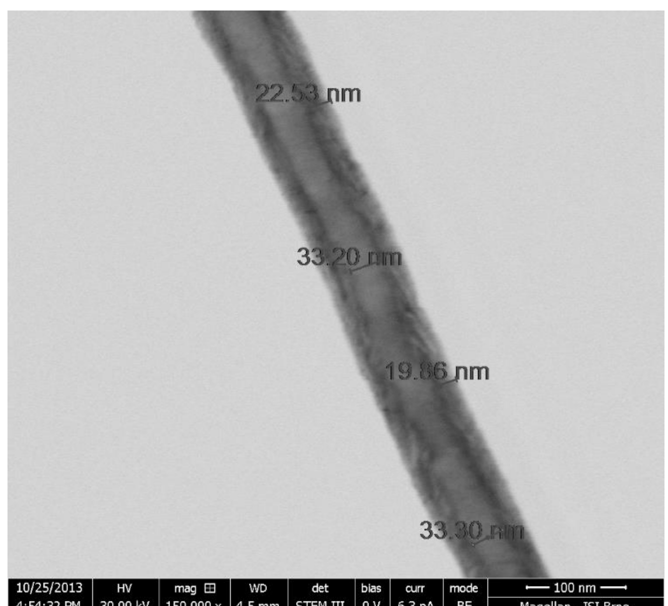
VYBRANÉ APLIKACE

Nanotrubky s Co nanočásticemi









Angewandte Chemie

Hydrogen Evolution Reaction

DOI: 10.1002/anie.201311111

Cobalt-Embedded Nitrogen-Rich Carbon Nanotubes Efficiently Catalyze Hydrogen Evolution Reaction at All pH Values**

*Xiaoxin Zou, Xiaoxi Huang, Anandarup Goswami, Rafael Silva, Bhaskar R. Sathe, Eliška Mikmeková, and Tewodros Asefa**

Abstract: *Despite being technically possible, splitting water to generate hydrogen is still practically unfeasible due mainly to the lack of sustainable and efficient catalysts for the half reactions involved. Herein we report the synthesis of cobalt-embedded nitrogen-rich carbon nanotubes (NRCNTs) that 1) can efficiently electrocatalyze the hydrogen evolution reaction (HER) with activities close to that of Pt and 2) function well under acidic, neutral or basic media alike, allowing them to be coupled with the best available oxygen-evolving catalysts—which also play crucial roles in the overall water-splitting reaction. The materials are synthesized by a simple, easily scalable synthetic route involving thermal treatment of Co^{2+}-*

catalyze the half reactions involved in the water-splitting reaction.[2]

The water-splitting reaction can be viewed as a combination of two half reactions: the hydrogen evolution reaction (HER) and the oxygen evolution reaction (OER).[2] To conduct electrochemical water splitting, voltages above the thermodynamic potential values corresponding to the intrinsic activation barriers present in both half reactions (also known as overpotential, η) must be applied. Hence, reduction of both overpotentials using HER or OER catalysts, respectively, is essential to make the water-splitting reaction less energy-intensive. Unfortunately, it is difficult to find suitable

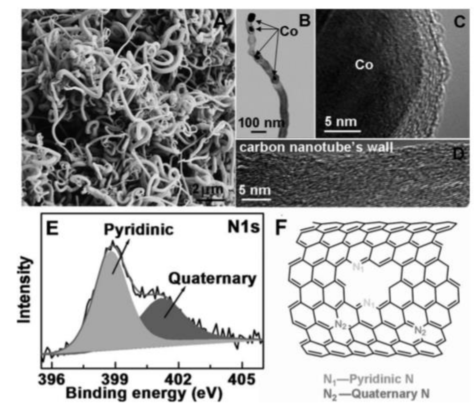
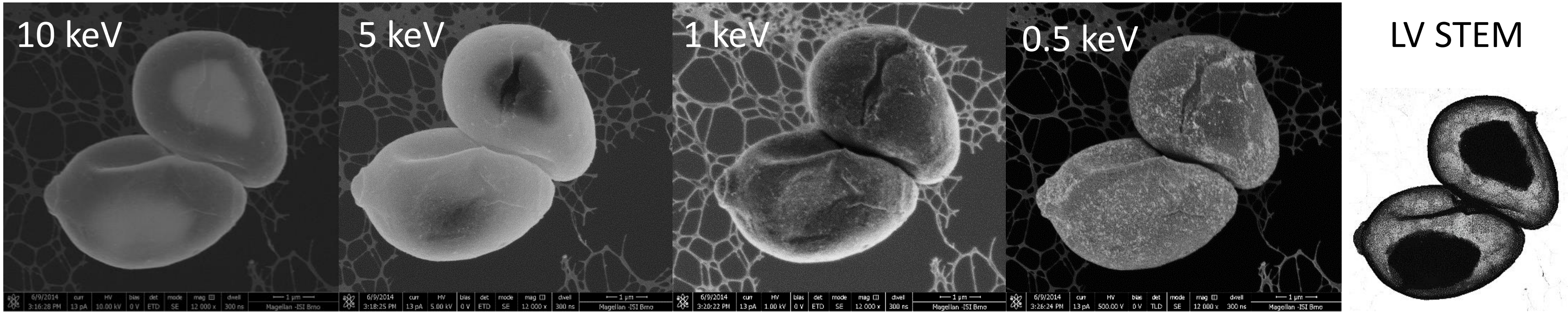
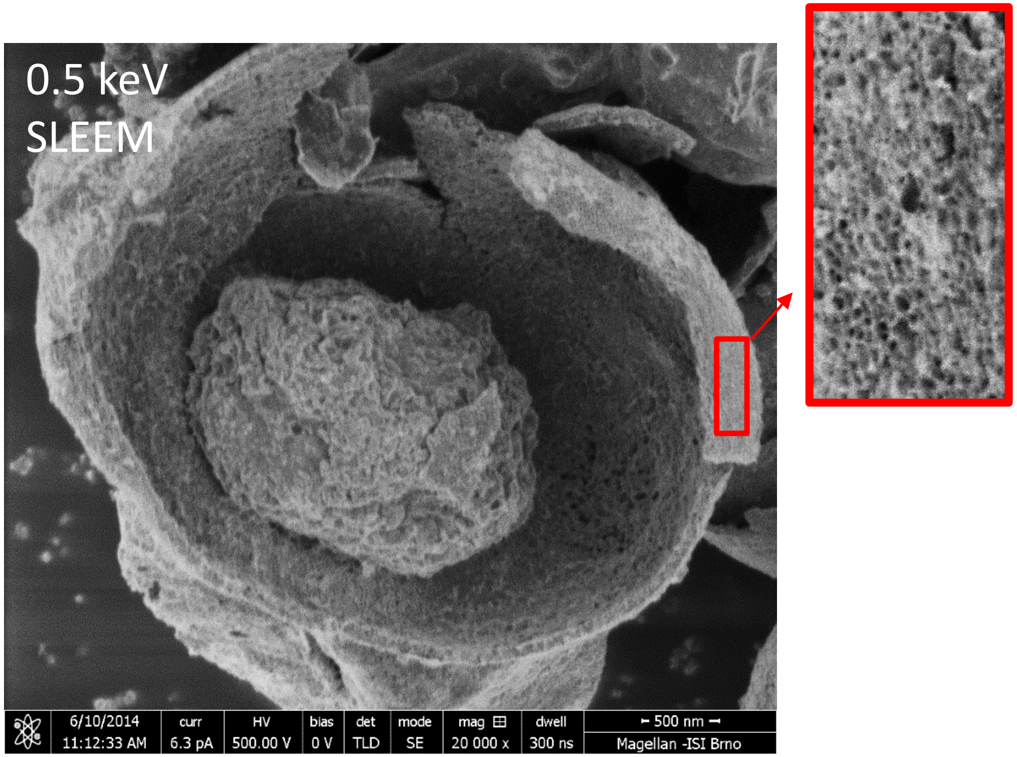


Figure 2. A) SEM image, B–D) STEM images, and E) N1s XPS spectrum of Co-NRCNTs. In the XPS spectrum, the raw curve (black) is peak-fitted into two curves (indicated by light gray and gray shaded areas) that correspond to two different types of N species (pyridinic and quaternary), and the sum of the two peak-fitted curves is shown with the gray curve. F) Representation of the two types of N dopants present in the Co-NRCNTs based on XPS results.

Uhlíkové mikročástice s aktivním jádrem





ACS APPLIED MATERIALS & INTERFACES

Research Article

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Yeast Cells-Derived Hollow Core/Shell Heteroatom-Doped Carbon Microparticles for Sustainable Electrocatalysis

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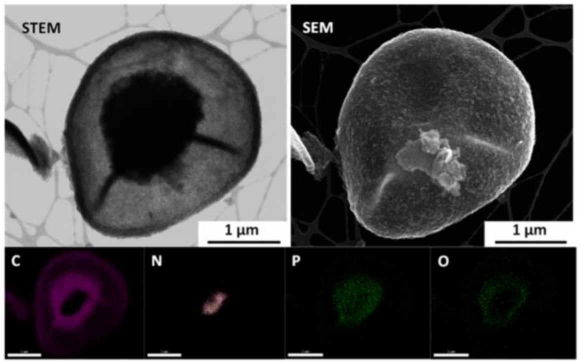
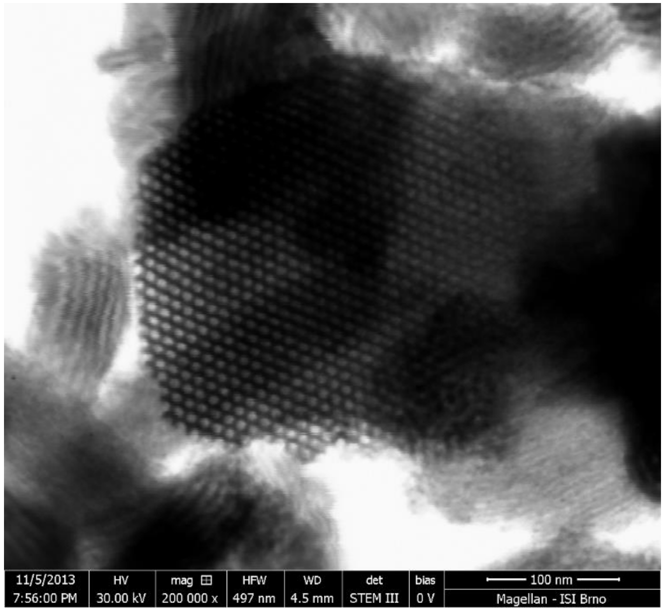
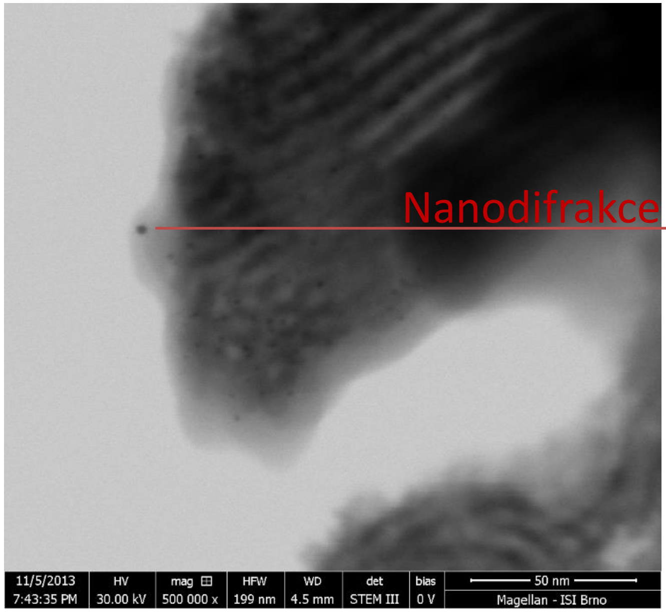
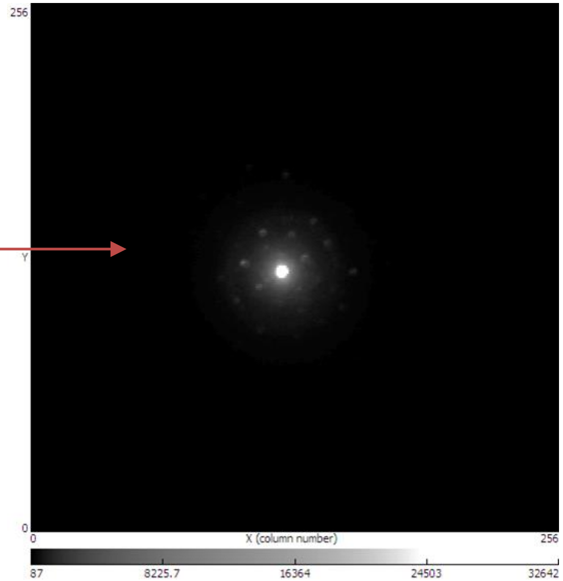
Supporting Information



Au nanočástice v organické struktuře







small
Gold Nanoclusters

Reductive Deprotection of Monolayer Protected Nanoclusters: An Efficient Route to Supported Ultrasmall Au Nanocatalysts for Selective Oxidation

Sayantani Das, Anandarup Goswami, Mahdi Hesari, Jafar F. Al-Sharab, Eliška Mikmeková, Flavio Maran, and Tewodros Asefa**

Bulk gold has long been considered too inert to be a catalyst until the discovery that Au nanoparticles (AuNPs) supported on metal oxides such as TiO_2, CeO_2 and Fe_2O_3 could be very active for CO oxidation.[1] Supported Au and other NPs have now been successfully shown to catalyze various chemical reactions.[2] AuNP-catalyzed oxidation reactions, in par- … to adsorb reactants relatively more strongly[7] and the magnitude of their HOMO-LUMO energy gaps.[8]

Among many oxidation reactions attempted using small Au NPs as catalyst, styrene oxidation is one of the most notable examples; although the reaction gives valuable oxygenated compounds, which can serve as precursors for many

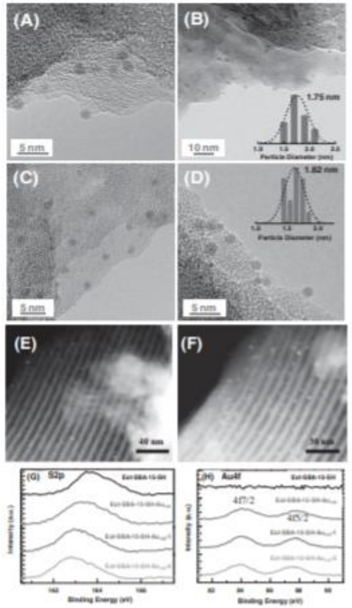
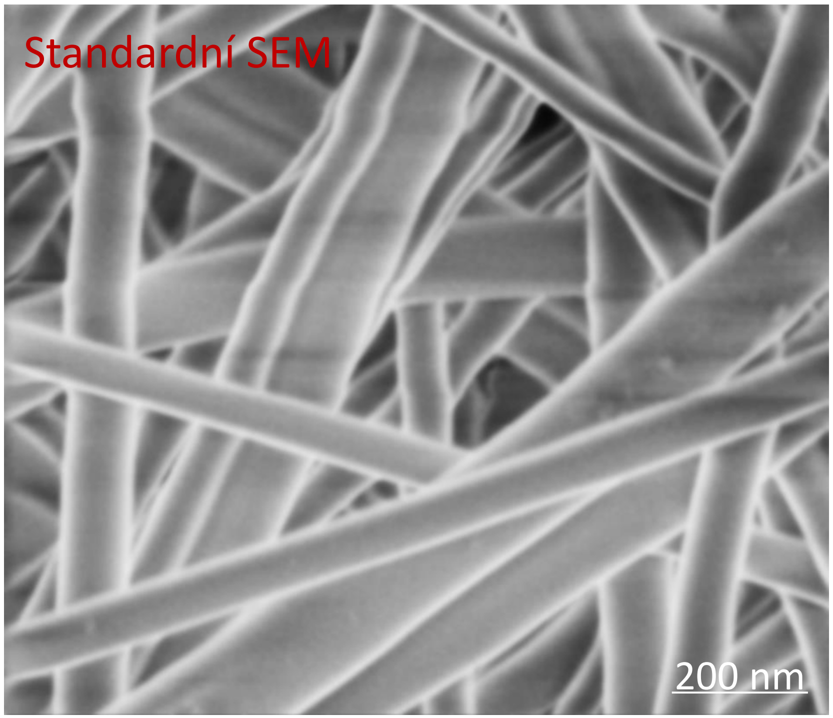
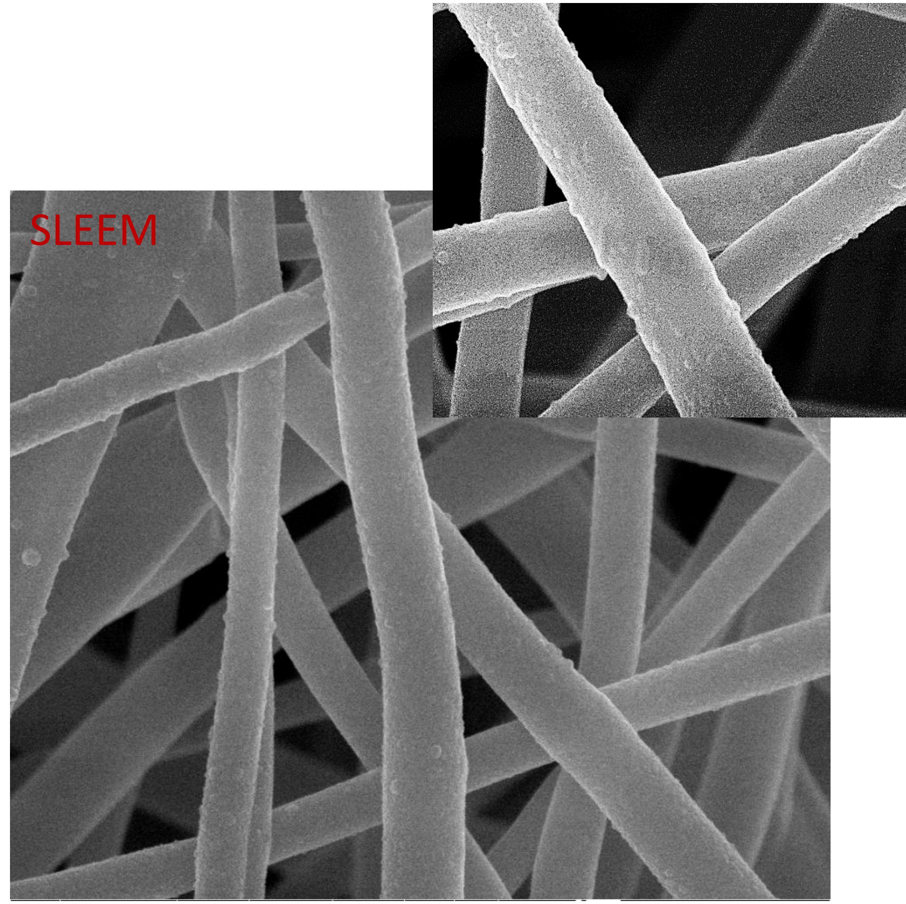


Figure 2. TEM images of (A,B) Ext-SBA-15-SH-Au_{144} and (C,D) Ext-SBA-15-SH-Au_{144}-5, with the corresponding size histograms, (E,F) HAADF-STEM images of Ext-SBA-15-SH-Au_{144} and Ext-SBA-15-SH-Au_{144}-5, and XPS spectra of (G) S2p and (H) Au4f peaks of Ext-SBA-15-SH, Ext-SBA-15-SH-Au_{144}, Ext-SBA-15-SH-Au_{144}-1, and Ext-SBA-15-SH-Au_{144}-5.

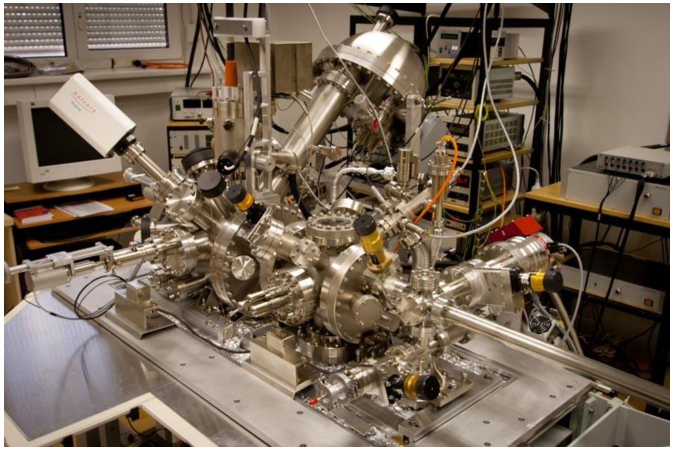




Smluvní výzkum pro skupinu doc. Lenky Zajíčkové (CEITEC MU Brno)

ÚPT AVČR

Co nabízíme?



SLEEM
LV STEM

Nabízíme **precizní nedestruktivní zobrazovací techniku**, nízko-napěťovou rastrovací (prozařovací) elektronovou mikroskopii (SLEEM, LV STEM), pro studium pokročilých nano-materiálů. Pozorování s rozlišením **pod 1 nm, s vysokým materiálovým kontrastem a povrchovou citlivostí, technika vhodná i pro nevodivé vzorky.** Chemická analýza z povrchu (Augerova spektroskopie) nebo z objemu (EDX), je možná in-situ.

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