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The collective behavior of nanowires: Synthesis of advanced network architectures with improved functional properties

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At the current stage of nanotechnology not individual nanoparticles or nanowires but rather systems of much greater complexity are increasingly becoming the subject of research. This transition is driven by the knowledge that the overall properties of a complex system are not only governed by the intrinsic characteristics of the nanoscale building blocks, but also strongly depend on the connectivity and distribution of the components in three-dimensional (3D) space.

Recently, we reported a method for the synthesis of nanowire networks and demonstrated that the organization of 1D nanostructures into specifically designed superstructures can result in a significant improvement of functional properties.[1] Our method allows the synthesis of macroscopically stable network structures with numerous independently controllable parameters. In the case of Pt, these supportless 3D network structures proved to be an excellent electrocatalyst, showing a high activity when catalyzing methanol oxidation.

Here, we take full advantage of the possibility to adjust many parameters defining both characteristics of individual nanowires and the arrangement of nanowires into complex structures in order to design advanced network architectures. The main concern of this work is to elucidate the effect of complexity on functional properties. We synthesized Pt nanowire networks of different integration level and investigated the electrocatalytic activity of the increasingly complex systems using cyclic voltammetry and chronoamperometry. The results are compared with state-of-the-art particle based electrocatalysts and other nanowire assemblies such as arrays. Moreover, our efforts towards the design of electrocatalysts with even higher mass activity are presented.

References:

[1] M. Rauber, I. Alber, S. Müller, R. Neumann, O. Picht, C. Roth, A. Schökel, M. E. Toimil-Molares, W. Ensinger, "Highly-Ordered Supportless Three-Dimensional Nanowire Networks with Tunable Complexity and Interwire Connectivity for Device Integration," Nano Letters, **11** (6), 2304-2310; (2011).