UNIVERSAL AND “GREEN” SYNTHESIS OF 2D-NANOMATERIALS AS ELECTROCATALYSTS

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HINTERGRUND

The 2D structures and tunable electronic, optical, and mechanical properties partly resulting from their large number of surface atoms with unsaturated bonds make two-dimensional (2D) nanosheets, fascinating materials particularly, but not only for electrocatalysis. The electrocatalytic conversion of the earth's abundant simple molecules into value-added basic chemicals is likely to change current chemical production methods with enormous socio-economic and environmental benefits. Therefore, 2D electrocatalysts have emerged as a new class of high performance electrocatalysts with a massive future potential due to the need to replace the scarce precious metal based catalysts commonly used in energy technology so far. In fact, CO_2 reduction to methane is already best catalyzed today by metal-free carbon nanosheets. Other possible applications of 2D electrocatalysts are in oxygen reduction, oxygen evolution, hydrogen evolution and methanol oxidation. Research efforts to optimize the development of these promising 2D nanomaterials have led to various synthesis strategies, in particular wet chemical synthesis with potential for large-scale production and broad applicability to various compounds. However, the current methods differ from one compound to another, which has so far prevented progress towards a general, universal manufacturing route.

PROBLEMSTELLUNG

The performance-to-cost ratio of common nanomaterials is still far from satisfactory. Current strategies have technical drawbacks, such as high costs (special equipment, expensive reactants), lengthy procedures (post-treatment, multi-step operations), low product quality, environmentally harmful conditions (non-green organic solvents) and use of surfactants. On the other hand, attention should also be paid to improve the performance of the end product to achieve a satisfactory performance-to-cost ratio. Therefore, a variety of methods have been developed while a universal, powerful synthesis strategy is missing.

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ENTWICKLUNGSSTAND

Teststadium

PATENTSITUATION

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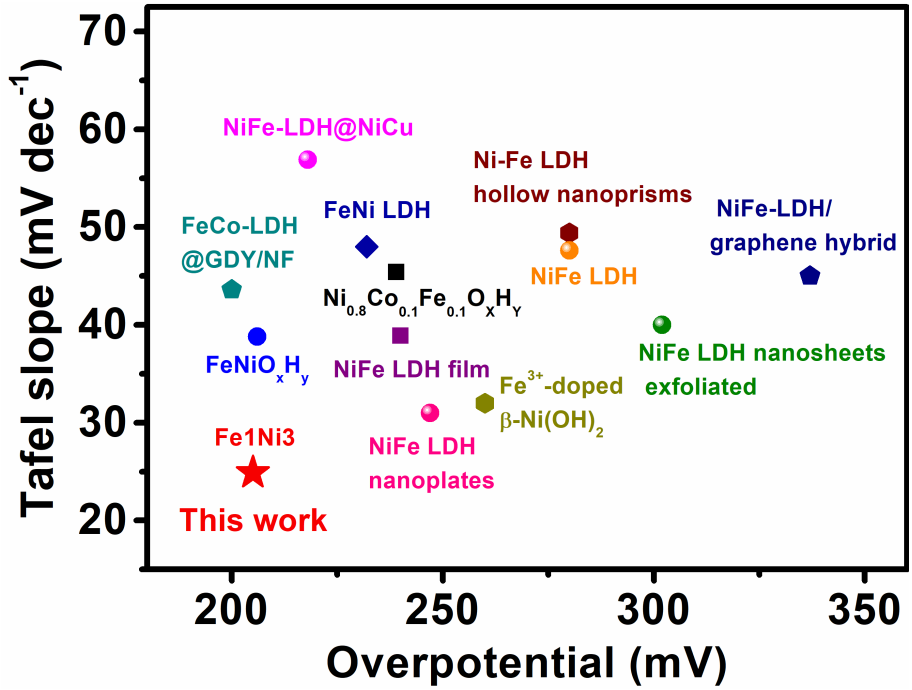
CATEGORIES

//Chemie

LÖSUNG

Novel 2D nanomaterials have been developed as electrocatalysts especially, but not only for the use in oxygen evolution reaction (OER), which can be prepared in a simple and universal, “green” and low-cost manner, while maintaining excellent performance. The synthetic strategy of the novel 2D nanomaterials is realized by a one-step co-precipitation, involving a gas diffusion technique or by mixing of two solutions.



2D Fe-doped Ni(OH)2 [University of Konstanz]

VORTEILE

- Universal “green” synthesis of novel 2D nanomaterials, low-cost and scalable
- Use of cheap and commonly available chemicals only
- Ambient conditions i.e. room temperature and water as solvent
- No use of surfactants means no impurities introduced, no reduction of

the catalytic activity
- Novel 2D nanomaterials show great catalytic performance
- One spatial direction, i.e. the thickness direction, can be set from 0.1 to 75 nm
- Any 2D morphology, including hexagonal morphology, circular morphology, strip morphology or sheet morphology is possible.
- The 2D nanomaterials are single crystalline or polycrystalline or agglomerates of crystalline

ANWENDUNGSBEREICHE

Possible applications of 2D electrocatalysts are in CO_2 reduction, oxygen reduction, oxygen evolution, hydrogen evolution and methanol oxidation. Electrochemical water splitting is considered to be a sustainable method for producing clean energy from water in the form of hydrogen. In this electrochemical process, however, the oxygen evolution reaction (OER) is the rate-limiting key step.

SERVICE

The Technologie-Lizenz-Büro GmbH is in charge of the exploitation of this technology and assists companies in obtaining a license.