



Oxidation

1- Critical review of advanced oxidation processes in organic wastewater treatment

By:

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Review

Abstract

With the development of industrial society, organic wastewater produced by industrial manufacturing has caused many environmental problems. The vast majority of organic pollutants in water bodies are persistent in the environment, posing a threat to human and animal health. Therefore, efficient treatment methods for highly concentrated organic wastewater are urgently needed. Advanced oxidation processes (AOPs) are widely noticed in the area of treating organic wastewater. Compared with other chemical methods, AOPs have the characteristics of high oxidation efficiency and no secondary pollution. In this paper, the mechanisms, advantages, and limitations of AOPs are comprehensively reviewed. Besides, the basic principles of combining different AOPs to enhance the treatment efficiency are described. Furthermore, the applications of AOPs in various wastewater treatments, such as oily wastewater, dyeing wastewater, pharmaceutical wastewater, and landfill leachate, are also presented. Finally, we conclude that the main direction in the future of AOPs are the modification of catalysts and the optimization of operating parameters, with the challenges focusing on industrial applications. (C) 2021 Published by Elsevier Ltd.

Keywords

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[AOPsCombination of AOPsPrinciplesCharacteristicsOrganic wastewater treatment](#)

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WET AIR OXIDATIONLANDFILL LEACHATE TREATMENTFENTON-LIKE PROCESSIN-SITUGENERATIONPHOTO-FENTONAZO-DYEELECTROCHEMICAL OXIDATIONCATALYTIC OZONATIONELECTRO-FENTONAQUEOUS-SOLUTION



Oxidation

2- Single-atom catalysis in advanced oxidation processes for environmental remediation

By:

[Shang, YN](#) (Shang, Yanan) [1]; [Xu, X](#) (Xu, Xing) [1]; [Gao, BY](#) (Gao, Baoyu) [1]; [Wang, SB](#) (Wang, Shaobin) [2]; [Duan, XG](#) (Duan, Xiaoguang) [2]

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Abstract

Emerging single atom catalysts (SACs), especially carbon-based SACs are appealing materials in environmental catalysis because of their ultrahigh performances, environmental friendliness, structural/chemical robustness, and the maximum utilization of active metal sites. The metal centres, carbon matrixes, and coordination characteristics collectively determine the electronic features of carbon-based SACs, and their behaviours in catalysing peroxide activation and efficiencies in advanced oxidation processes (AOPs). However, there is lack of a comprehensive and critical review reporting the successful marriage of carbon-based SACs in AOP-based remediation technologies. It is particularly necessary to systematically compare and reveal the catalytic sites and the associated mechanisms of carbon-based SACs in diverse AOP systems. In this review, we highlight the synthetic strategies, characterisation, and computation of carbon-based SACs, and for the first time, showcase their innovative applications in AOP technologies. We unveil the origins of versatile catalytic oxidation pathways in different AOP systems and the mechanisms of micropollutant degradation over carbon-based SACs, distinguished from the upsized counterparts (metals/oxides and carbon substrates). We also provide directions to the rational design of on-demand SACs for green chemistry and environmental sustainability.



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Also, we suggest a designated and integrated experimental/theoretical protocol for revealing the structure-catalysis relations of SACs in AOP applications, and propose the prospects for future opportunities and challenges.

Keywords

Keywords Plus

[OXYGEN REDUCTION REACTION](#) [METAL-ORGANIC FRAMEWORKS](#) [NITROGEN-DOPED GRAPHENE](#) [ENHANCED PHOTOCATALYTIC OZONATION](#) [SULFAMETHOXAZOLE DEGRADATION](#) [ROLE](#) [EFFICIENT HYDROGEN EVOLUTION](#) [RADICAL-BASED OXIDATION](#) [FENTON-LIKE DEGRADATION](#) [VISIBLE-LIGHT](#) [ACTIVE-SITES](#)



Oxidation

3- Amorphous type FeOOH modified defective BiVO₄ photoanodes for photoelectrochemical water oxidation

By:

[Lu, XY](#) (Lu, Xinyu) [1]; [Ye, KH](#) (Ye, Kai-hang) [2], [3]; [Zhang, SQ](#) (Zhang, Siqi) [1]; [Zhang, JN](#) (Zhang, Jingnan) [2]; [Yang, JD](#) (Yang, Jindong) [2]; [Huang, YC](#) (Huang, Yongchao) [1]; [Ji, HB](#) (Ji, Hongbing) [2]

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Abstract

Herein, a new approach of inducing oxygen vacancy in BiVO₄/FeOOH nanostructures is designed, where metal trichalcogenide is introduced. The strategy involves integration of Bi₂S₃ quantum dots (QDs) in BiVO₄/FeOOH to construct defect-rich BiVO₄/FeOOH (denoted Vo-BiVO₄/FeOOH) as high-performance photoanode for photoelectrochemical water oxidation. Both experimental and theoretical analysis confirm that the excellent PEC performance is due to the introduction of oxygen vacancies and FeOOH cocatalyst, which significantly improves the charge separation. As a result, the obtained Vo-BiVO₄/FeOOH photoanode not only demonstrates an optimized Photoelectrochemical (PEC) performance for water oxidation, with photocurrent density of 4.71 mA cm⁻² at 1.23 V versus RHE under AM 1.5 G illumination but the interaction of BiVO₄ with FeOOH cocatalyst also significantly enhance the stability for Vo-BiVO₄/FeOOH without any decrease after 11 h. The oxygen vacancy and FeOOH can effectively enhance the light conversion efficiency, charge transfer efficiencies and charge separation efficiency. This work highlights an effective strategy towards achieving efficient and stable BiVO₄ photoanode for sustainable solar energy conversion.



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Keywords

Author Keywords

[BiVO₄](#) [Water oxidation](#) [Oxygen vacancy](#) [Photoanode](#)

Keywords Plus

[OXYGEN VACANCIES-](#)

[SCHEME](#) [HYDROGEN FILMS](#) [PERFORMANCE](#) [FABRICATION](#) [EFFICIENCY](#) [NANOSHEETS](#) [SELENIDE](#) [CARRIERS](#)



Oxidation

4- Interface dynamics of Pd-CeO₂ single-atom catalysts during CO oxidation

By:

[Muravev, V](#) (Muravev, Valery) [1]; [Spezzati, G](#) (Spezzati, Giulia) [1]; [Su, YQ](#) (Su, Ya-Qiong) [1]; [Parastaev, A](#) (Parastaev, Alexander) [1]; [Chiang, FK](#) (Chiang, Fu-Kuo) [2]; [Longo, A](#) (Longo, Alessandro) [3], [4]; [Escudero, C](#) (Escudero, Carlos) [5]; [Kosinov, N](#) (Kosinov, Nikolay) [1]; [Hensen, EJM](#) (Hensen, Emiel J. M.) [1]

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Abstract

In recent years, noble metals atomically dispersed on solid oxide supports have become a frontier of heterogeneous catalysis. In pursuit of an ultimate atom efficiency, the stability of single-atom catalysts is pivotal. Here we compare two Pd/CeO₂ single-atom catalysts that are active in low-temperature CO oxidation and display drastically different structural dynamics under the reaction conditions. These catalysts were obtained by conventional impregnation on hydrothermally synthesized CeO₂ and one-step flame spray pyrolysis. The oxidized Pd atoms in the impregnated catalyst were prone to reduction and sintering during CO oxidation, whereas they remained intact on the surface of the Pd-doped CeO₂ derived by flame spray pyrolysis. A detailed in situ characterization linked the stability of the Pd single atoms to the reducibility of the Pd-CeO₂ interface and the extent of reverse oxygen spillover. To understand the chemical phenomena that underlie the metal-support interactions is crucial to the rational design of stable single-atom catalysts.

Keywords



Oxidation

Keywords Plus

ATOMICALLY DISPERSED PDIN-SITUSUPPORT INTERACTIONSCERIA CATALYSTSOXIDE SUPPORTSPLATINUMACTIVATIONIDENTIFICATIONNANOPARTICLESREDUCIBILITY



Oxidation

5- Reactive species in advanced oxidation processes: Formation, identification and reaction mechanism

By:

[Wang, JL](#) (Wang, Jianlong) [1], [2]; [Wang, SZ](#) (Wang, Shizong) [1], [2]

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Abstract

The formation, identification and reaction mechanism of reactive species in various advanced oxidation processes (AOPs) are crucial for understanding the principles of AOPs and the degradation mechanism of recalcitrant organic contaminants because reactive species are responsible for the degradation of organic contaminants in AOPs. In this review, the possible reactive species generated in various AOPs (such as Fenton oxidation, photochemical oxidation, electrochemical oxidation, ozonation, gamma ray/electron beam radiation, persulfate-based oxidation, wet air oxidation and ultrasonic oxidation), were systematically analyzed and summarized, including hydroxyl radicals (HO center dot), hydrogen radical (HO center dot), hydrated electron (e(aq)(-)), sulfate radicals (SO4 center dot(-)), peroxymonosulfate radicals (SO5 center dot(-)), superoxide radicals (O-2 center dot), singlet oxygen (O-1(2)) and hydroperoxy radicals (HO2 center dot). The factors that influence the formation of reactive species were discussed, mainly including pH, inorganic anions and dissolved organic matter. The main identification methods, such as electron spin resonance (ESA), electron paramagnetic electron (EPR), high performance liquid chromatography (HPLC), transient absorption spectrum, quenching experiments and kinetic analysis, were introduced, and the reaction mechanism of reactive species with organic contaminants were discussed. Finally, concluding remarks and perspectives were proposed. This review paper will provide an insight into the formation, identification and reaction mechanism of reactive species in AOPs, which is helpful for reader to better understand the degradation mechanism of recalcitrant organic contaminants in various AOPs.

Keywords



Oxidation

Author Keywords

[Advanced oxidation processes](#)[Reactive species](#)[Quenching](#)[Scavenger](#)[Free radical](#)[Reaction mechanism](#)

Keywords Plus

[ELECTRON-SPIN-RESONANCESULFATE RADICAL-ANIONWET AIR OXIDATIONACTIVATED PERSULFATE OXIDATIONDISINFECTION BY-PRODUCTSBORON-DOPED DIAMONDACID ORANGE 7HYDROXYL RADICALSSINGLET OXYGENRATE CONSTANTS](#)



Oxidation

6- Efficient Nitrogen Fixation to Ammonia through Integration of Plasma Oxidation with Electrocatalytic Reduction

By:

[Li, LQ](#) (Li, Laiquan) [1]; [Tang, C](#) (Tang, Cheng) [1]; [Cui, XY](#) (Cui, Xiaoyang) [2]; [Zheng, Y](#) (Zheng, Yao) [1]; [Wang, XS](#) (Wang, Xuesi) [1]; [Xu, HL](#) (Xu, Haolan) [3]; [Zhang, S](#) (Zhang, Shuai) [2]; [Shao, T](#) (Shao, Tao) [2]; [Davey, K](#) (Davey, Kenneth) [1]; [Qiao, SZ](#) (Qiao, Shi-Zhang) [1]

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Abstract

Present one-step N₂ fixation is impeded by tough activation of the N equivalent to N bond and low selectivity to NH₃. Here we report fixation of N₂-to-NH₃ can be decoupled to a two-step process with one problem effectively solved in each step, including: 1) facile activation of N₂ to NO_x⁻ by a non-thermal plasma technique, and 2) highly selective conversion of NO_x⁻ to NH₃ by electrocatalytic reduction. Importantly, this process uses air and water as low-cost raw materials for scalable ammonia production under ambient conditions. For NO_x⁻ reduction to NH₃, we present a surface boron-rich core-shell nickel boride electrocatalyst. The surface boron-rich feature is the key to boosting activity, selectivity, and stability via enhanced NO_x⁻ adsorption, and suppression of hydrogen evolution and surface Ni oxidation. A significant ammonia production of 198.3 $\mu\text{mol cm}^{-2} \text{h}^{-1}$ was achieved, together with nearly 100 % Faradaic efficiency.

Keywords



Oxidation

Author Keywords

[ammonia production](#)[boron-rich surface](#)[electrocatalytic nitrate reduction](#)[nitrogen fixation](#)[plasma](#)



Oxidation

7- MOF-derived CeO₂ supported Ag catalysts for toluene oxidation: The effect of synthesis method

By:

[Wang, YX](#) (Wang, Yuxin) [1]; [Bi, FK](#) (Bi, Fukun) [2]; [Wang, YY](#) (Wang, Yunyun) [2]; [Jia, MH](#) (Jia, Minghan) [3]; [Tao, XF](#) (Tao, Xuefen) [1]; [Jin, YX](#) (Jin, Yinxiu) [1]; [Zhang, XD](#) (Zhang, Xiaodong) [2]

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Abstract

Volatile organic compounds (VOCs), such as toluene, have aroused wide concerns its emissions growth and harmfulness. Catalytic oxidation has been considered as one of the most efficient technologies for toluene degradation. In this work, MOF-derived CeO₂ supported Ag catalysts were prepared by different synthesis method. Toluene oxidation test found that Ag-Ce-BTC-C synthesized by one-pot and calcination at 500 degrees C under Ar and O₂ atmosphere exhibited the better catalytic performance for toluene oxidation (T₉₀ = 226 degrees C). H₂ temperature programmed reduction and X-ray photoelectron spectroscopic results exhibited that the preparation method had a great influence on the physicochemical properties of the supported Ag catalysts. The better catalytic performance was attributed to the better reducibility, more active oxygen species and oxygen vacancies, higher molar ratio of Oads/Olat, Ce³⁺/Ce⁴⁺ and Ag⁰/Ag^{delta+}. This work has a certain guiding significance for the preparation of highly active MOF-derived supported catalysts.

Keywords

Author Keywords

[MOF derivatives](#)[Ag catalysts](#)[Toluene oxidation](#)[Synthesis method](#)

Keywords Plus



Oxidation

[METAL-ORGANIC FRAMEWORKSPHOTOCATALYTIC DEGRADATIONSOOT
OXIDATIONPERFORMANCE REDUCTIONNANOPARTICLESTETRACYCLINEPYROLYSISAG/AL₂O₃CO₃O₄](#)



Oxidation

8- High-valence metals improve oxygen evolution reaction performance by modulating 3dmetal oxidation cycle energetics

By:

[Zhang, B](#) (Zhang, Bo) [1], [2]; [Wang, L](#) (Wang, Lie) [1], [2]; [Cao, Z](#) (Cao, Zhen) [3]; [Kozlov, SM](#) (Kozlov, Sergey M.) [3]; [de Arquer, FPG](#) (Garcia de Arquer, F. Pelayo) [4]; [Dinh, CT](#) (Dinh, Cao Thang) [4]; [Li, J](#) (Li, Jun) [5]; [Wang, ZY](#) (Wang, Ziyun) [4]; [Zheng, XL](#) (Zheng, Xueli) [4]; [Zhang, LS](#) (Zhang, Longsheng) [1], [2]; ...More

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Abstract

Multimetal oxyhydroxides have recently been reported that outperform noble metal catalysts for oxygen evolution reaction (OER). In such 3d-metal-based catalysts, the oxidation cycle of 3dmetals has been posited to act as the OER thermodynamic-limiting process; however, further tuning of its energetics is challenging due to similarities among the electronic structures of neighbouring 3dmetal modulators. Here we report a strategy to reprogram the Fe, Co and Ni oxidation cycles by incorporating high-valence transition-metal modulators X (X = W, Mo, Nb, Ta, Re and MoW). We use in situ and ex situ soft and hard X-ray absorption spectroscopies to characterize the oxidation transition in modulated NiFeX and FeCoX oxyhydroxide catalysts, and conclude that the lower OER overpotential is facilitated by the readier oxidation transition of 3dmetals enabled by high-valence modulators. We report an similar to 17-fold



Oxidation

mass activity enhancement compared with that for the OER catalysts widely employed in industrial water-splitting electrolyzers.

Keywords

Keywords Plus

[WATER OXIDATION CATALYST ELECTROCATALYSTS REDUCTION OXIDE SITES](#)



Oxidation

9- Redirecting dynamic surface restructuring of a layered transition metal oxide catalyst for superior water oxidation

By:

[Wang, J](#) (Wang, Jian) [1]; [Kim, SJ](#) (Kim, Se-Jun) [2]; [Liu, JP](#) (Liu, Jiapeng) [3]; [Gao, Y](#) (Gao, Yang) [4]; [Choi, S](#) (Choi, Subin) [1]; [Han, J](#) (Han, Jeongwoo) [1]; [Shin, H](#) (Shin, Hyeyoung) [5]; [Jo, S](#) (Jo, Sugeun) [1]; [Kim, J](#) (Kim, Juwon) [1]; [Ciucci, F](#) (Ciucci, Francesco) [3], [6]; ...More

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Abstract

Rationally manipulating the in situ formed catalytically active surface of catalysts remains a tremendous challenge for a highly efficient water electrolysis. Here we present a cationic redox-tuning method to modulate in situ catalyst leaching and to redirect the dynamic surface restructuring of layered $\text{LiCoO}_2-x\text{Cl}_x$ ($x = 0, 0.1$ or 0.2), for the electrochemical oxygen evolution reaction (OER). Chlorine doping lowered the potential to trigger in situ cobalt oxidation and lithium leaching, which induced the surface of $\text{LiCoO}_{1.8}\text{Cl}_{0.2}$ to transform into a self-terminated amorphous (oxy)hydroxide phase during the OER. In contrast, Cl-free LiCoO_2 required higher electrochemical potentials to initiate the in situ surface reconstruction to spinel-type $\text{Li}_1 \pm x\text{Co}_2\text{O}_4$ and longer cycles to stabilize it. Surface-restructured $\text{LiCoO}_{1.8}\text{Cl}_{0.2}$ outperformed many state-of-the-art OER catalysts and demonstrated remarkable stability. This work makes a stride in modulating surface restructuring and in designing superior OER electrocatalysts via manipulating the in situ catalyst leaching.



Oxidation

10- Cobalt single atom site catalysts with ultrahigh metal loading for enhanced aerobic oxidation of ethylbenzene

By:

[Xiong, Y](#) (Xiong, Yu) [1], [2]; [Sun, WM](#) (Sun, Wenming) [3]; [Han, YH](#) (Han, Yunhu) [4]; [Xin, PY](#) (Xin, Pingyu) [2]; [Zheng, XS](#) (Zheng, Xusheng) [5]; [Yan, WS](#) (Yan, Wensheng) [5]; [Dong, JC](#) (Dong, Juncai) [6]; [Zhang, J](#) (Zhang, Jian) [2]; [Wang, DS](#) (Wang, Dingsheng) [2]; [Li, YD](#) (Li, Yadong) [2]

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Abstract

The oxidation of hydrocarbons to produce high value-added compounds (ketones or alcohols) using oxygen in air as the only oxidant is an efficient synthetic strategy from both environmental and economic views. Herein, we successfully synthesized cobalt single atom site catalysts (Co SACs) with high metal loading of 23.58 wt.% supported on carbon nitride (CN), which showed excellent catalytic properties for oxidation of ethylbenzene in air. Moreover, Co SACs show a much higher turn-over frequency (19.6 h⁻¹) than other reported non-noble catalysts under the same condition. Comparatively, the as-obtained nanosized or homogenous Co catalysts are inert to this reaction. Co SACs also exhibit high selectivity (97%) and stability (unchanged after five runs) in this reaction. DFT calculations reveal that Co SACs show a low energy barrier in the first elementary step and a high resistance to water, which result in the robust catalytic performance for this reaction.

Keywords



Oxidation

Author Keywords

[single atom sitehigh-loading catalystsheterogeneous catalystsethylbenzene oxidation](#)

Keywords Plus

[OXYGEN REDUCTIONSELECTIVE OXIDATIONELECTRONIC-STRUCTUREDOPED](#)

[GRAPHENECARBONEFFICIENTNANOPARTICLESACETOPHENONEINSIGHT](#)



Oxidation

11- Effect of inorganic anions on the performance of advanced oxidation processes for degradation of organic contaminants

By:

[Wang, JL](#) (Wang, Jianlong) [1], [2]; [Wang, SZ](#) (Wang, Shizong) [1], [2]

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Abstract

Inorganic anions, such as chloridion, carbonate, phosphate, sulfate and nitrate are ubiquitous in water, they will react with hydroxyl radical and sulfate radical produced during advanced oxidation processes (AOPs), to form chlorine radical, carbonate radical nitrate radical, phosphate radical and sulfate radical, which have a significant influence on the transformation of organic pollutants. It is generally believed that the quenching effect of inorganic anions on reactive species produced in AOPs was the main reason to influence the performance of AOPs. While this reason cannot explain all the results. In addition, at present most of studies only focused on the effect of inorganic anions on the removal efficiency of targeted organic pollutant by AOPs. For better understanding the effect of inorganic anions on the performance of AOPs, it is crucial to comprehensively evaluate the effect of inorganic anions on AOPs. In this review paper, the effect of inorganic anions (such as chloridion, carbonate, phosphate, sulfate and nitrate) on the performance of AOPs, including the transformation of reactive species, stability of oxidants, catalytic activity of catalysts and degradation products, was systematically summarized and reviewed. Firstly, their effect on the formation and transformation of reactive species was discussed, then the effect on the stability of oxidants (H₂O₂ and persulfate) and catalysts was introduced. Furthermore, the effect on the



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catalytic activity of catalysts was analyzed. Finally, the effect on the degradation intermediate products of organic pollutants was summarized. This review will provide an insight into the underlying influence mechanism of inorganic anions on AOPs, which is conducive to comprehensively evaluate the effect of inorganic anions on the performance of AOPs.

Keywords

Author Keywords

[Advanced oxidation processes](#)[Inorganic anions](#)[Reactive species](#)[Catalytic activity](#)[Degradation products](#)

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[ACTIVATED PERSULFATE OXIDATION](#)[RADICAL-INDUCED DEGRADATION](#)[ACID ORANGE 7](#)[HYDROGEN-PEROXIDE](#)[RATE CONSTANT](#)[SURFACE COMPLEXATION](#)[PHOSPHATE RADICAL](#)[HYDROXYL RADICAL](#)[AQUEOUS-SOLUTION](#)[PHENOLIC-COMPOUNDS](#)



Oxidation

12- Sulfate radicals-based advanced oxidation technology in various environmental remediation: A state-of-the-art review

By:

[Ushani, U](#) (Ushani, Uthirakrishnan) [1]; [Lu, XQ](#) (Lu, Xueqin) [1], [2], [3]; [Wang, JH](#) (Wang, Jianhui) [1]; [Zhang, ZY](#) (Zhang, Zhongyi) [1]; [Dai, JJ](#) (Dai, Jinjin) [1]; [Tan, YJ](#) (Tan, Yujie) [1]; [Wang, SS](#) (Wang, Shasha) [1]; [Li, WJ](#) (Li, Wanjiang) [1]; [Niu, CX](#) (Niu, Chengxin) [1]; [Cai, T](#) (Cai, Teng) [1]; ...More

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Review

Abstract

Sulfate radicals are well-known for their strong oxidation potential (2.60 V), their high reaction rate (10⁶-10⁹ M/s) and longer life span ($t_{1/2}$ = 30-40 μ s). Owing to the revealed impact it is accomplished by oxidizing, many pesticides, dye, and heavy organic substances such as waste activated sludge (WAS) in a very short time duration. In this review, current research exploration, novel encounters, long pathway of sulfate radicals travelling in environmental management and commercial implementation prominence to persulfate oxidation process are abridged and revealed. A broad evaluation analysis intended in this review established its mesmerizing ascendancies over the conventional persulfate oxidation process with respect to rapid, more efficient, broad pH range and outstanding reaction. Regardless of the abundant improvement attained earlier, there are still several challenges for persulfate activation through transition metals such as heavy metal deposit, metal leaching, removal of sulfate, reusability, etc. To tackle the overhead complications, a novel scenario catalyst with a non-radical pathway, i.e. carbon-grounded catalyst (activated carbon, graphene oxide, biochar, etc.) is under extensive trials. The challenge and practical problems faced in the course of sulfate radical usage are deliberated and the upcoming need for a study to promote full-scale implementations of those approaches are proposed.

Keywords



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Author Keywords

[Sulfate radicals](#)[Pollutant degradation](#)[Sludge dewaterability](#)[Transition metals](#)[Carbon grounded catalyst](#)

Keywords Plus

[ZERO-VALENT IRONACTIVATED PERSULFATE OXIDATIONEXTRACELLULAR POLYMERIC SUBSTANCESACID ORANGE 7NEAR-NEUTRAL PHANAEROBICALLY DIGESTED-SLUDGEMODIFIED CARBON NANOTUBESSEWAGE-SLUDGEWASTE-WATERENHANCED DEWATERABILITY](#)



Oxidation

13- In-situ reconstructed Ru atom array on alpha-MnO₂ with enhanced performance for acidic water oxidation

By:

[Lin, C](#) (Lin, Chao) [1], [2]; [Li, JL](#) (Li, Ji-Li) [3]; [Li, XP](#) (Li, Xiaopeng) [1]; [Yang, S](#) (Yang, Shuai) [4]; [Luo, W](#) (Luo, Wei) [1]; [Zhang, YJ](#) (Zhang, Yaojia) [1]; [Kim, SH](#) (Kim, Sung-Hae) [2]; [Kim, DH](#) (Kim, Dong-Hyung) [2]; [Shinde, SS](#) (Shinde, Sambhaji S.) [2]; [Li, YF](#) (Li, Ye-Fei) [3]; ...More

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Abstract

The development of acid-stable oxygen evolution reaction electrocatalysts is essential for high-performance water splitting. Here, we report an electrocatalyst with Ru-atom-array patches supported on alpha-MnO₂ (Ru/MnO₂) for the oxygen evolution reaction following a mechanism that involves only *O and *OH species as intermediates. This mechanism allows direct O-O radical coupling for O₂ evolution. Ru/MnO₂ shows high activity (161 mV at 10 mA cm⁻²) and outstanding stability with small degradation after 200 h operation, making it one of the best-performing acid-stable oxygen evolution reaction catalysts. Operando vibrational and mass spectroscopy measurements were performed to probe the reaction intermediates and gaseous products for validating the oxygen evolution reaction pathway. First-principles calculations confirmed the cooperative catalysis mechanism with a reduced energy barrier. Time-dependent elemental analysis demonstrated the occurrence of the in-situ dynamic cation exchange reaction during the oxygen evolution reaction, which is the key for triggering the reconstruction of Ru atoms into the ordered array with high durability.



Oxidation

Keywords

Keywords Plus

[SURFACE WALKING METHOD](#) [OXYGEN EVOLUTION](#) [TITANIA](#)

[ANATASE](#) [MECHANISM](#) [CATALYST](#) [EFFICIENT](#) [NANOPARTICLES](#) [REDUCTION](#) [ELECTROCATALYSTS](#) [ACTIVATION](#)



Oxidation

14- Electrochemical advanced oxidation processes for wastewater treatment: Advances in formation and detection of reactive species and mechanisms

By:

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Review

Abstract

Over the past three decades, the knowledge of the mechanisms of electrochemical advanced oxidation processes (EAOPs) has progressively evolved with the advances in analytical and spectrometric techniques. A comprehensive understanding of the types and mechanisms of production of reactive species in EAOPs is a prerequisite to the understanding of their reactivities and elucidation of intermediate products generated during the oxidation process and degradation pathways. The type, nature, and quantity of reactive species generated in electrochemical treatment processes are controlled by many factors, including the type of the treatment technique, electrode/electrocatalyst materials, water/wastewater composition, water pH conditions, and operating parameters. Depending on the technique and operating parameters, single or multiple oxidants can be produced alone or combined electrochemical processes. However, the potency and reactivity of each oxidant are quite similar regardless of the technique, except in the case of heterogeneous and homogeneous hydroxyl radicals. This minireview presents the current state of mechanisms and models of reactive species generated in different EAOPs, highlighting different methods for their identification and reactivity.

Keywords

Author Keywords



Oxidation

[Electrochemical oxidation](#)[Reactive species](#)[Mechanism](#)[Degradation kinetics](#)[Mineralization](#)

Keywords Plus

[STOICHIOMETRIC TITANIUM-OXIDE](#)[HETEROGENEOUS ELECTRO-FENTON](#)[DOPED DIAMOND](#)

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[ELECTRODE](#)[DEGRADATION](#)[ANODE](#)[EFFICIENCY](#)[PHOTOELECTROCATALYSIS](#)



Oxidation

15- Short-Range Ordered Iridium Single Atoms Integrated into Cobalt Oxide Spinel Structure for Highly Efficient Electrocatalytic Water Oxidation

By:

[Shan, JQ](#) (Shan, Jieqiong) [1], [2]; [Ye, C](#) (Ye, Chao) [1], [2]; [Chen, SM](#) (Chen, Shuangming) [3]; [Sun, TL](#) (Sun, Tulai) [4], [5]; [Jiao, Y](#) (Jiao, Yan) [1], [2]; [Liu, LM](#) (Liu, Lingmei) [6]; [Zhu, CZ](#) (Zhu, Chongzhi) [4], [5]; [Song, L](#) (Song, Li) [3]; [Han, Y](#) (Han, Yu) [6]; [Jaroniec, M](#) (Jaroniec, Mietek) [7], [8]; ...More

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Abstract

Noble metals manifest themselves with unique electronic structures and irreplaceable activity toward a wide range of catalytic applications but are unfortunately restricted by limited choice of geometric structures spanning single atoms, clusters, nanoparticles, and bulk crystals. Herein, we propose how to overcome this limitation by integrating noble metal atoms into the lattice of transition metal oxides to create a new type of hybrid structure. This study shows that iridium single atoms can be accommodated into the cationic sites of cobalt spinel oxide with short-range order and an identical spatial correlation as the host lattice. The resultant Ir_{0.06}Co_{2.94}O₄ catalyst exhibits much higher electrocatalytic activity than the parent oxide by 2 orders of magnitude toward the challenging oxygen evolution reaction under acidic conditions. Because of the strong interaction between iridium and cobalt oxide support, the Ir_{0.06}Co_{2.94}O₄ catalyst shows significantly improved corrosion resistance under acidic conditions and



Oxidation

oxidative potentials. This work eliminates the "close-packing" limitation of noble metals and offers promising opportunity to create analogues with desired topologies for various catalytic applications.

Keywords

Keywords Plus

[TOTAL-ENERGY CALCULATIONS](#)[HYDROGEN EVOLUTION](#)[OXYGEN EVOLUTION](#)[CATALYST DESIGN](#)[COMPLEX SURFACE](#)[METALS](#)[GOLD](#)



Oxidation

16- Manufacturing Process Development for Belzutifan, Part 3: Completing a Streamlined Through-Process with a Safe and Scalable Oxidation

By:

[Chen, ZW](#) (Chen, Zhiwei) [1]; [Marzijarani, NS](#) (Marzijarani, Nastaran Salehi) [1]; [Quirie, S](#) (Quirie, Scott) [1]; [Pirrone, GF](#) (Pirrone, Gregory F.) [2]; [Dalby, SM](#) (Dalby, Stephen M.) [1]; [Wang, T](#) (Wang, Tao) [1]; [Kim, J](#) (Kim, Jungchul) [1]; [Peng, F](#) (Peng, Feng) [1]; [Fine, AJ](#) (Fine, Adam J.) [1]

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Abstract

We report the development of a modified Kornblum oxidation mediated by 2-picoline N-oxide for the synthesis of belzutifan that circumvented safety and stench problems associated with the original clinical supply route conditions. A robust quench for the crude bromination stream with 1,3-dimethoxybenzene and 2,6-lutidine enabled a single-solvent through-process that avoided the isolation of a mutagenic intermediate and resulted in a significantly lower process mass intensity. A ternary-solvent, constant-volume distillation was then used to crystallize the ketone product directly from the reaction mixture.

Keywords

Author Keywords

[oxidationthrough-processprocess developmentprocess safetymanufacturing route developmentrenal cell carcinomaRCChypoxia-inducible factor-2 alphaHIF-2 alpha](#)

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[HYPOXIA-INDUCIBLE FACTORBENZYLIC OXIDATIONNN-OXIDECONVENIENT OXIDATIONAROMATIC-ALDEHYDESDIMETHYL-SULFOXIDEORGANIC HALIDESHIF-ALPHASCALE-UPSOLVENT](#)



Oxidation

17- Iridium single-atom catalyst on nitrogen-doped carbon for formic acid oxidation synthesized using a general host-guest strategy

By:

[Li, Z](#) (Li, Zhi) [1]; [Chen, YJ](#) (Chen, Yuanjun) [1]; [Ji, SF](#) (Ji, Shufang) [1]; [Tang, Y](#) (Tang, Yan) [1]; [Chen, WX](#) (Chen, Wenxing) [1]; [Li, A](#) (Li, Ang) [2]; [Zhao, J](#) (Zhao, Jie) [3]; [Xiong, Y](#) (Xiong, Yu) [1]; [Wu, YE](#) (Wu, Yuen) [4]; [Gong, Y](#) (Gong, Yue) [5]; ...More

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Abstract

Single-atom catalysts not only maximize metal atom efficiency, they also display properties that are considerably different to their more conventional nanoparticle equivalents, making them a promising family of materials to investigate. Herein we developed a general host-guest strategy to fabricate various metal single-atom catalysts on nitrogen-doped carbon (M-1/CN, M = Pt, Ir, Pd, Ru, Mo, Ga, Cu, Ni, Mn). The iridium variant Ir-1/CN electrocatalyses the formic acid oxidation reaction with a mass activity of 12.9 $\text{Amg}(\text{Ir})(-1)$ whereas an Ir/C nanoparticle catalyst is almost inert (similar to $4.8 \times 10^{-3} \text{Amg}(\text{Ir})(-1)$). The activity of Ir-1/CN is also 16 and 19 times greater than those of Pd/C and Pt/C, respectively. Furthermore, Ir-1/CN displays high tolerance to CO poisoning. First-principle density functional theory reveals that the properties of Ir-1/CN stem from the spatial isolation of iridium sites and from the modified electronic structure of iridium with respect to a conventional nanoparticle catalyst.

Keywords

Keywords Plus



Oxidation

[TOTAL-ENERGY CALCULATION](#)[SOXYGEN REDUCTION](#)[POROUS](#)
[CARBON](#)[NANOPARTICLES](#)[COELECTROCATALYST](#)[IDENTIFICATION](#)[NANOCATALYSTS](#)[NANOCRYSTALS](#)[REMOV](#)
[AL](#)



Oxidation

18- NiFe Layered-Double-Hydroxide Nanosheet Arrays on Graphite Felt: A 3D Electrocatalyst for Highly Efficient Water Oxidation in Alkaline Media

By:

[Ding, P](#) (Ding, Peng) [1], [2]; [Meng, CQ](#) (Meng, Chuqian) [1]; [Liang, J](#) (Liang, Jie) [1]; [Li, TS](#) (Li, Tingshuai) [1]; [Wang, Y](#) (Wang, Yan) [1]; [Liu, Q](#) (Liu, Qian) [3]; [Luo, YL](#) (Luo, Yonglan) [3]; [Cui, GW](#) (Cui, Guanwei) [4]; [Asiri, AM](#) (Asiri, Abdullah M.) [5], [6]; [Lu, SY](#) (Lu, Siyu) [2]; ...More

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Abstract

It is of great importance to rationally design and develop earth-abundant nanocatalysts for high-efficiency water electrolysis. Herein, NiFe layered double hydroxide was in situ grown hydrothermally on a 3D graphite felt (NiFe LDH/GF) as a high-efficiency catalyst in facilitating the oxygen evolution reaction (OER). In 1.0 M KOH, NiFe LDH/GF requires a low overpotential of 214 mV to deliver a geometric current density of 50 mA cm⁻² ($\eta(50 \text{ mA cm}^{-2}) = 214 \text{ mV}$), surpassing that NiFe LDH supported on a 2D graphite paper (NiFe LDH/GP; $\eta(50 \text{ mA cm}^{-2}) = 301 \text{ mV}$). More importantly, NiFe LDH/GF shows good durability at 50 mA cm⁻² within 50 h of OER catalysis testing and delivers a faradaic efficiency of nearly 100% in the electrocatalysis of OER.

Keywords

Keywords Plus

[OXYGEN EVOLUTION PERFORMANCE SURFACE ELECTRODE NANOARRAY CATALYST HYDROGEN](#)



Oxidation

19- A review of the recent advances on the treatment of industrial wastewaters by Sulfate Radical-based Advanced Oxidation Processes (SR-AOPs)

By:

[Giannakis, S](#) (Giannakis, Stefanos) [1]; [Lin, KYA](#) (Lin, Kun-Yi Andrew) [2], [3], [4]; [Ghanbari, F](#) (Ghanbari, Farshid) [5]

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Review

Abstract

Over the last years, Sulfate Radical-based Advanced Oxidation Processes (SR-AOPs) have received considerable attention due to their high versatility and efficacy in disinfection and decontamination. Their advantages over classical AOPs, the generation of sulfate radicals ($\text{SO}_4^{\cdot-}$) from peroxydisulfate (PDS, $\text{S}_2\text{O}_8^{2-}$), or joint sulfate and hydroxyl radicals (HO^{\cdot}) production from peroxymonosulfate (PMS, HSO_5^-) and their abundant activation methods have facilitated their introduction into various remediation and effluent decontamination processes. In this review, we present the advances in the field of industrial wastewater (IWW) treatment by SR-AOPs, by activation of either PMS or PDS via any suitable method, in homogeneous or heterogeneous (photo)catalytic processes. This review aims to present the state of the art in SR-AOPs application for IWW treatment, and act as a guideline of the field advances, summarize the previous application experiences, hence avoid research pitfalls and empower better IWW treatment practices. After an integrated presentation of the dominant pathways towards IWW decontamination, we discuss the SR-AOPs application in the treatment of effluents such as landfill leachate, petrochemical and pharmaceutical WW, pulp or paper industry effluents, textile and winery WW, as well as less studied processes such as coking, olive mill or soil washing effluents. Finally, the advantages and shortcomings of SR-AOPs for IWW treatment, as well as their perspectives are discussed.

Keywords



Oxidation

Author Keywords

[Sulfate radical](#)[Advanced oxidation processes](#)[Industrial wastewater](#)[Persulfate activation](#)[Peroxymonosulfate \(PMS\)](#)

Keywords Plus

[WASTE-WATER TREATMENT](#)[LANDFILL LEACHATE TREATMENT](#)[ZERO-VALENT IRON](#)[BED FENTON PROCESS](#)[ACTIVATED PERSULFATE](#)[RATE CONSTANTS](#)[ORGANIC-MATTER](#)[HYDROGEN-PEROXIDE](#)[HYDROXYL RADICAL](#)[SCOD REMOVAL](#)



Oxidation

20- One-pot thermal polymerization route to prepare N-deficient modified g-C₃N₄ for the degradation of tetracycline by the synergistic effect of photocatalysis and persulfate-based advanced oxidation process

By:

[Sun, HR](#) (Sun, Haoran) [1]; [Guo, F](#) (Guo, Feng) [1]; [Pan, JJ](#) (Pan, Jingjing) [1]; [Huang, W](#) (Huang, Wei) [3]; [Wang, K](#) (Wang, Kai) [1]; [Shi, WL](#) (Shi, Weilong) [2]

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Abstract

N-deficient g-C₃N₄ (CN_x) photocatalyst was synthesized via a simple one-step thermal polymerization of urea and oxamide for the degradation of tetracycline (TC) under visible-light irradiation in the presence of persulfate (PS) activation. The microstructure and morphology of CN_x were investigated by a host of characteristic technologies. The experimental result revealed that CN_x/PS system displays a high efficiency in the photocatalytic process of TC degradation. The effects of different environmental factors (catalyst dose, PS dose, initial TC concentration and initial pH) on the degradation of the system were investigated. The possible intermediates products were discussed based on the liquid chromatography-mass spectrometry (LC-MS) analysis. Moreover, the toxicity of the TC solution over CN_x/PS synergistic photocatalytic system was studied by the culture of bean sprouts, demonstrated that the aquatic toxicity of the TC after degradation of the system was effectively reduced.

Keywords

Author Keywords

[N-deficient g-C₃N₄](#)[Persulfate activation](#)[Visible-light](#)[Photocatalysis](#)[Advanced oxidation process](#)[Tetracycline](#)

Keywords Plus



Oxidation

[GRAPHITIC CARBON NITRIDE NITROGEN DEFECTS PEROXYMONOSULFATE PMS HYDROGEN EVOLUTION POROUS G-C₃N₄ HETEROJUNCTION WATER ACTIVATION KINETICS DOTS](#)