Electronic Supplementary Information for

Sewage sludge-based functional nanomaterials: development and applications

Shi-Jie Yuan, Xiao-Hu Dai*

State Key Laboratory of Pollution Control and Resource Reuse, College of Environmental Science and Engineering, Tongji University, Shanghai, 200092, China

***Corresponding author:**

Prof. Xiao-Hu Dai, Phone: +86-21-65986297; Fax: +86-21-65983602; E-mail: daixiaohu@tongji.edu.cn

Table S1. SS for synthesizing SFNs compared with other options for SS disposal

SS disposal	Restrictions	Reference
Landfilling	Release of heavy metals, organic pollutants and pathogens. Surface and underground water contamination. Leachate from landfill requires treatment. The increasing price of land.	*Environ. Pollut.* 2002, 118, 393-399.
Ocean dumping	Release of heavy metals, organic pollutants and pathogens. Destroy the marine environment.	*Waste Manage.* 2012, 32, 1186-1195.
Incineration	Release of heavy metals. The handling of solid residues, e.g. bed and filter ash. Emissions of dioxins and furans, NOx, N_2O, SO_2, as HCl, HF and C_xH_y. Permits of building an incineration plant. Costs (including costs for treatment of flue gases and ashes)	*Chem. Eng. J.* 2003, 96, 197-205.
Land applications	Heavy metals accumulate in the topsoil and crops. Acceptance from food industry and public. Health effects and infectious risks. The inclusion of emerging pathogens.	*Waste Manage.* 2008, 28, 347-358. *Environ. Sci. Technol*. 2011, 45, 5459-5469.
The advantages of SS for synthesizing SFNs		
SS for synthesizing SFNs	Convert approximately half of the organic matter into renewable liquid fuels and chemical feedstock Concentrates the heavy metals in a solid carbonaceous residue	*Water Res*. 2009, 43, 2569-2594; *Waste Manage.* 2012, 32, 1186-1195

Table S2. Synthesis and properties of the SFNs

Starting materials	Synthesis process	Property	Activity	Synergistically enhanced performances	Reference
SS $FeSO_4 \cdot 7H_2O$	One-step method combing synthesis with loading	SS-derived char supported Fe_3O_4	Heterogeneous Fenton-like catalyst	SiO_2 and Al_2O_3 of the SS strongly correlates with the high catalytic performance	*Chem. Eng. J.* 2012, **185-186**, 44-51.
SS $FeSO_4 \cdot 7H_2O$	One-step method combing synthesis with loading	SS-supported Fe_2O_3	Heterogeneous catalyst for photo-Fenton reaction under both UV and vis light irradiation	One-electron transfer between the specific small inorganic molecular or metal oxides in the SS and the loaded Fe compound	*Appl. Catal. B: Environ*., 2014, **154**, 252-258
SS iron sludge	One-step method combining carbonization and Fe-loading	SS-derived carbon-supported iron oxide	Three-dimensional heterogeneous electro-Fenton oxidation	Unique Fe species embedded in carbon matrix structure	*J. Taiwan Inst. Chem. E.*, 2016, **60**, 352-360.
SS	One-step pyrolysis method at 800 °C	Sludge Carbon	Microparticle electrode for adsorption and electro-oxidation	Co-Fenton-like effect of the SiO_2 and Al_2O_3	*Ind. Eng. Chem. Res*., 2015, **54**, 5468-5474.
SS	Physicochemical activation and carbonization	SS-derived porous carbon with magnetic property	Adsorption and Fenton-like degradation	Co-catalytic effect of carbon plane, iron oxide and other mineral like silica or alumina	*J. Hazard. Mater.*, 2013 **246-247**,145-153.
SS	KOH activation, microwave digestion in the HNO_3 solutions at pH 1, pyrolysis	Magnetic porous carbon containing Fe_3O_4	Fenton-like degradation	Co-catalytic effect of carbon plane, iron oxide and other mineral like silica or alumina	*Bioresour. Technol*., 2014, **118**, 638-642.
SS	SS-derived carbonaceous	SS-derived carbon	Fenton-like wet	Co-catalytic effect of the	*RSC Adv*., 2015, **5**,

	materials treated with different kinds of acid	with surface modification	peroxide oxidation	surface-modified groups after oxyacid treatment with the co-catalytic effect of the inherent component of the SS, Fe^{3+}, and SiO_2	41867-41876.
SS	Carbonization; physical activation (steam or CO_2) and chemical activation (K_2CO_3); HCl washing	SS-based activated carbons	Wet air oxidation	Free radicals generated by the surface functional carbonyl group and the active metal species (especially Fe species)	*Appl. Catal. B: Environ.*, 2011, **101**, 306-316.
SS	Carbonization; physical activation (steam or CO_2) and chemical activation (K_2CO_3); HCl washing	SS-based activated carbons	Wet air oxidation	Free radicals generated by the surface functional carbonyl group and the active metal species (especially Fe species)	*Appl. Catal. B: Environ*., 2011, **110**, 81-89.
SS	Carbonization, different kinds of acids washing	SS-based carbons	Wet air oxidation	High content of iron and surface functional groups	*Catal. Sci. Technol*., 2016, **6**, 1085-1093.
SS $FeSO_4 \cdot 7H_2O$	One-step method combining the carbon synthesis with the Fe loading	SS-derived carbon-supported iron oxide	Wet air oxidation	High content of iron and surface functional groups	*J. Hazard. Mater.*, 2014, **276**, 88-96.
SS	Physicochemical activation and carbonization	SS-derived carbon	Heterogeneous catalytic ozonation	SS-derived carbon-based SFN with O_3	*J. Hazard. Mater.*, 2012, **239-240**, 381-388.
SS Mn and Fe	$ZnCl_2$ activation, carbonization, wet	SS based activated carbon supported	Heterogeneous catalytic ozonation	SS-derived carbon-based SFN with O_3	*Bioresour. Technol*., 2014, **166**, 178-186.

nitrate	impregnation	manganese and ferric oxides			
SS $TiOSO_4 \cdot 2H_2O$	One-step hydrothermal process	Sewage sludge support and in situ doped TiO_2	Heterogeneous TiO_2 photocatalyst	*In situ* doping of TiO_2 with transition metals (Fe, Cu, and Cr) originating from the sewage sludge	*RSC Adv*., 2014, **4**, 61036-61044.
SS	Facile one-step pyrolysis process, immersed in 20 wt% HF	N, O-codoped SFN	Electrochemical energy storage	Hierarchical porous structure and heteroatom doping effects	*RSC Adv*., 2015, **5**, 45827-45835.
SS	Carbonization,30% HF solution and KOH activation	3D honeycomb-like hierarchically structured carbon	Electrochemical energy storage	Hierarchically structured	*J. Mater. Chem. A*, 2015, **3**, 15225-15234.
SS	One-step carbonation process	SS biochars	ORR electrocatalysts	Abundant micropores, and high nitrogen and iron contents	*Bioresour. Technol*., 2013, **144**, 115-120.
SS	One-step carbonation process, acids washing	N, Fe, and S co-doped carbon	ORR electrocatalysts	Multi-doped heteroatoms	*Sci. Rep.*, 2016, **6,** 27570.
SS coconut shells	Mixed, carbonation	SS-derived biochar	ORR electrocatalysts	Enhanced electrical conductivity, N, P, and the N-coordinated Fe groups	*J. Mater. Chem. A,* 2015, **3**, 8475-8482.
SS	Carbonation in NH_3, HCl washed	N, Fe, and S multi-doped carbon	ORR electrocatalysts	Multi-doped heteroatoms	*Green Chem*. 2016, **18**, 4004-4011.