



## Supplementary Materials

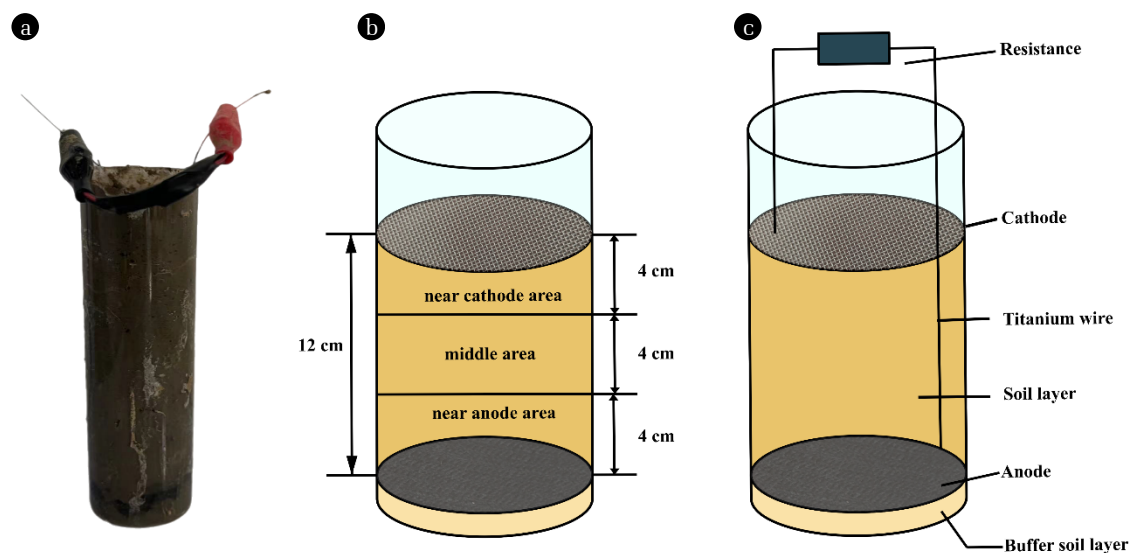


Fig. S1. (a) Set-up photograph; (b) sample point; (c) set-up diagram

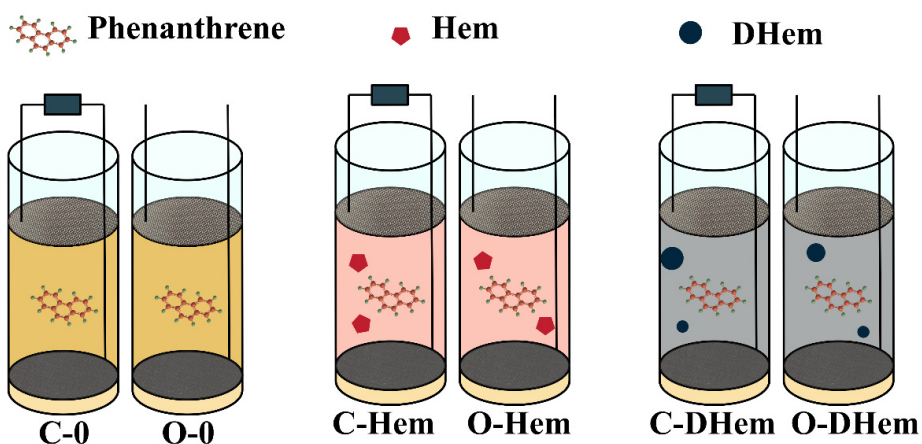


Fig. S2. Experiment grouping

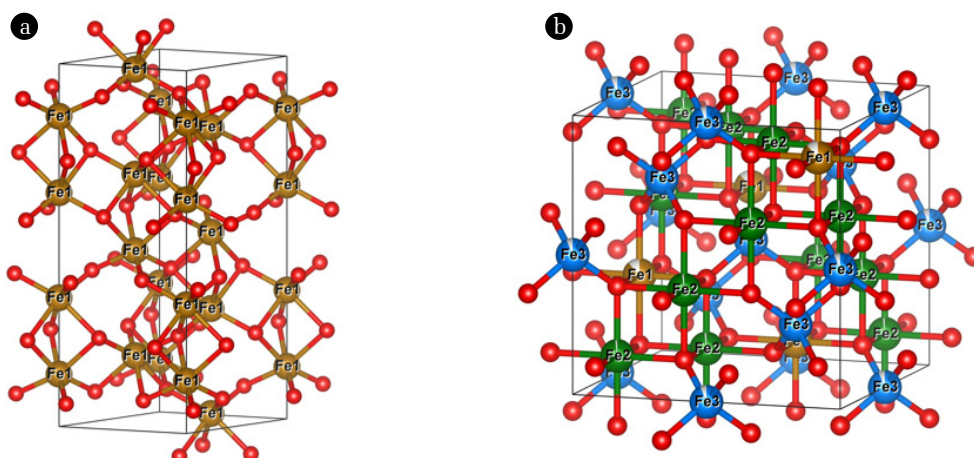


Fig. S3. Structural diagram minerals: (a) Hem; (b) Hem

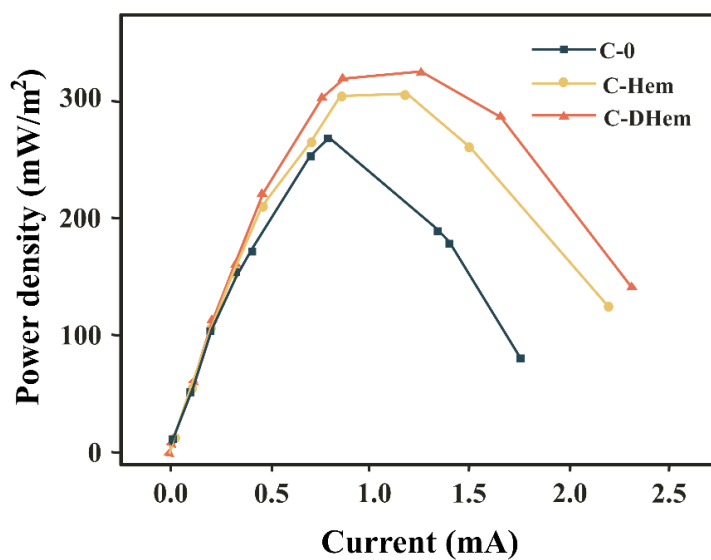
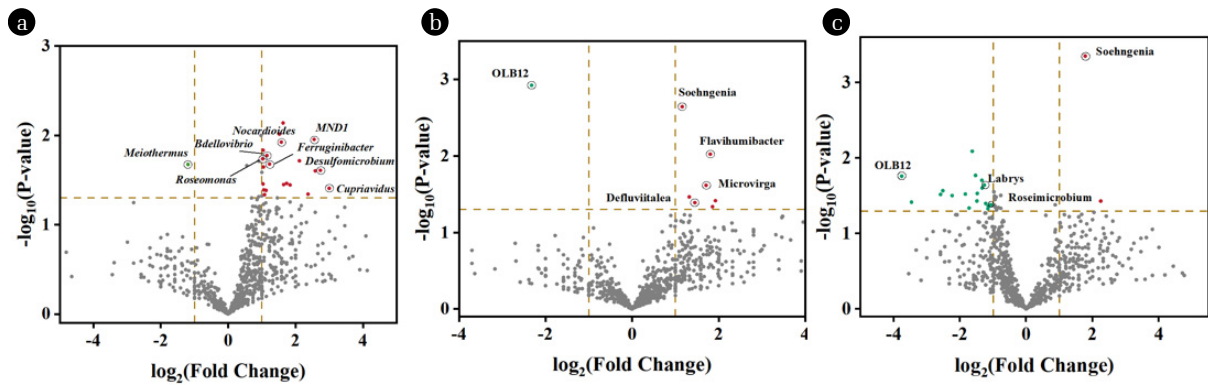


Fig. S4. Power density curve



**Fig. S5.** Volcano plot of microbial community structure of different groups: (a) C-0 and C-Hem; (b) C-0 and C-DHem; (c) C-Hem and C-DHem

**Table S1.** Comparison of power density of different devices

System	Method	$p_{\max}$ (mW/m <sup>2</sup> )	ERC-30 (mW/m <sup>2</sup> )	Reference
C-0	ERC-30	279	279	-
C-Hem	ERC-30	324	324	-
C-DHem	ERC-30	385	385	-
Single-chamber MFC	ERC-15	400	380	[1]
two-chamber Soil-MFCs	ERC-30	305	305	[2]
two-chamber MFCs	LSV	11.5	6.2	[3]

**Table S2.** Peak division area ratio of O 1S peaks in the XPS energy spectrum

Sample	$O_{\text{lat}}$ /eV	$O_{\text{vac}}$ /eV	$O_{\text{hyd}}$ /eV	Area1	Area2	Area3	Ration [Area2/Area(1+2+3)]/%
Hem	529.61	531.38	532.00	85778	7027	13055	6.64
DHem	529.78	531.07	531.5	91602	55716	20571	33.19

**Table S3.** Correlation analysis of different elements

Elements	Phenanthrene degradation	Voltage	Dissolved Fe(II)
Dissimilating iron-reducing bacterium	-0.030	0.549**	0.478*
Microorganisms that produce electricity and degrade PAHs	0.723*	0.409**	0.202*
Dissolved Fe(II)	0.796**	0.867**	1

## References

1. Moon JM, Kondaveeti S, Lee TH, Song YC, Min B. Minimum interspatial electrode spacing to optimize air-cathode microbial fuel cell operation with a membrane electrode assembly. *Bioelectrochemistry*. 2015;106:263-267. <https://doi.org/10.1016/j.bioelechem.2015.07.011>
2. Tang M, Sun Y, Cao X, Jiang X, Gao X, Li X. Promotion Mechanism of Atrazine Removal from Soil Microbial Fuel Cells by Semiconductor Minerals. *Sustainability*. 2023;15:7706. <https://doi.org/10.3390/su15097706>
3. Wang H, Liu J, Gui C, et al. Synergistic remediation of Cr(VI) contaminated soil by iron-loaded activated carbon in two-chamber microbial fuel cells. *Environ. Res.* 2022;208:112707. <https://doi.org/10.1016/j.envres.2022.112707>