

**Effective methane biodegradation through *in situ* coupling with  
*Methanotroph* and HK@SB-1 MOFs**

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The PCR product was sequenced to obtain the specific sequence: > *Methanotrophs*  
*bacteria*-Contig1

TCGTCCCCCTTGCGGTAGACTAACTACTTCTGGTAAACCCACTCCCA  
TGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCGACA  
TGCTGATCCGCGATTACTAGCGATTCCGACTTCATGCTCTCGAGTTGCAGA  
GAACAATCCGGACTACGATCGGCTTTCTGAGATTAGCTCCCCCTCGCGGG  
TTGGCAACTCTCTGTACCGACCATTTGTATTACGTGTGAAGCCCTGGCCATA  
AGGGCCATGAGGACTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGG  
CAGTCCCATTAAAGTGCCCAACTCAATGATGGCAATTAATGGCAAGGGTT  
GCGCTCGTTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACA  
GCCATGCAGCACCTGTGTCCACTTTCCCTTACGGGCACCTAATGCATCTCT  
GCTTCGTTAGTGGCATGTCAAGGCCAGGTAAGGTTTTTCGCGTTGCATCGA  
ATTAATCCACATAATCCACCGCTTGTGCGGGCCCCCGTCAATTCCTTTGAG  
TTTTAATCTTGCGACCGTACTCCCCAGGCGGTCTACTTCACGCGTTAGCTG  
CGTTACTCATGGATTTTACTCCACCAACAACACTAGTAGACATCGTTTAGGGC  
GTGGACTACCAGGGTATCTAATCCTGTTTGCTCCCCACGCTTTCGTGCATG  
AGCGTCAATATTATCCCAGGGGGCTGCCTTCGCCATTGGTATTCCTCCACA  
TCTCTACGCATTTCACTGCTACACGTGGAATTCTACCCCCCTCTGACATAT  
TCTAGTCTTGTAGTTTCAAACGCAGTTCCCAAGTTGAGCTCGGGGATTTC  
CATCTGACTTACAAAACCGCCTGCGCACGCTTTACGCCAGTAATTCCGAT  
TAACGCTCGCACCCCTACGTATTACCGCGGCTGCTGGCACGTAGTTAGCCG

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GTGCTTCTTATCAAGGTACCGTCAGCCTCACACTTTATTAGAATGTAAGTT  
TTCTTCCCTTGCGAAAGAGCTTTACAACCCGAAGGCCTTCTTCACTCACGC  
GGAATGGCTGGATCAGGCTTGCGCCCATTGTCCAAAATTCCCCACTGCTG  
CCTCCCGTAGGAGTCTGGACCGTGTCTCAGTTCCAGTGTGGCTGGTCGTCC  
TCTCAGACCAGCTACTGATCGTCGCCTTGGTAGGCCATTACCCACCAACT  
AGCTAATCAGATATCGGCCGCTCTTATAACGTAAGGTCCGAAGATCCCCT  
ACTTCCCCCTCAGGGCGTATGCGGTATTAGCTAATCTTTCGACTAGTTAT  
CCCCATTACAAGGTACGTTCCGATATATTACTCACCCGTTTCGCCACTAAT  
CCCCTTAGCAAGCTAAGGTCATCGTTCGACTG

### **Adsorbent thermal stability**

Figure S4 presents the thermogravimetric (TG) curves of HKUST-1 and HK@SB-1. The TG distributions of HKUST-1 and HK@SB-1 are highly similar, and their weight loss curves can be divided into three stages. In the first stage, observed in the temperature range of 30 to 100 °C, the first reaction corresponds to the loss of adsorbed water and solvent molecules. The bound water undergoes decomposition in the second stage between 100 and 250 °C. The final stage, in the range of 250 to 600 °C, shows that HKUST-1 has a final weight loss rate of 35.74%, while HK@SB-1 has a final weight loss rate of 34.50%. This can be attributed to the decomposition of the remaining BTC ligands and the collapse of the MOF structure. The results indicate that compared to HKUST-1, HK@SB-1 exhibits a slightly higher decomposition temperature,

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demonstrating better thermal stability of the composite due to the incorporation of SBA-16<sup>1, 2</sup>.

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## References

1. C. Chen, H. Wang, Y. Chen, X. Wei, W. Zou, H. Wan, L. Dong and G. Guan, Layer-by-layer self-assembly of hierarchical flower-like HKUST-1-based composite over amino-tethered SBA-15 with synergistic enhancement for CO<sub>2</sub> capture, *Chem. Eng. J.*, 2021, **413**, 127396.
2. C. Chen, B. Li, L. Zhou, Z. Xia, N. Feng, J. Ding, L. Wang, H. Wan and G. Guan, Synthesis of Hierarchically Structured Hybrid Materials by Controlled Self-Assembly of Metal–Organic Framework with Mesoporous Silica for CO<sub>2</sub> Adsorption, *ACS. Appl. Mater & Inter.*, 2017, **9**, 23060-23071.

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## Captions to Figures

**Fig. S1** DNA fragment electrophoresis of *Methanotrophs* (The amplified PCR product was subjected to agarose gel electrophoresis (2  $\mu$ l sample and 6  $\mu$ l bromophenol blue) at 300 V for 12 minutes to obtain the identification gel) .

**Fig. S2** Phylogenetic tree of *Methanotroph* (The phylogenetic tree was constructed using MAGE 7.0 software)

**Fig. S3** Thermogravimetric curves of HKUST-1 and HK@SB-1

Fig. S1:

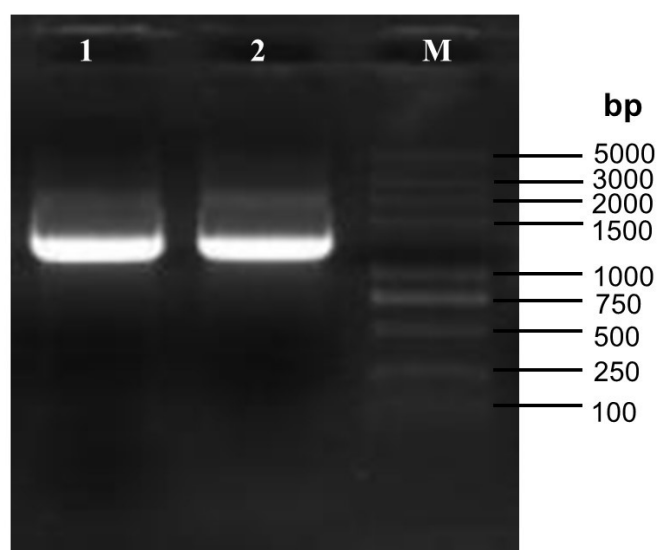


Fig. S2:

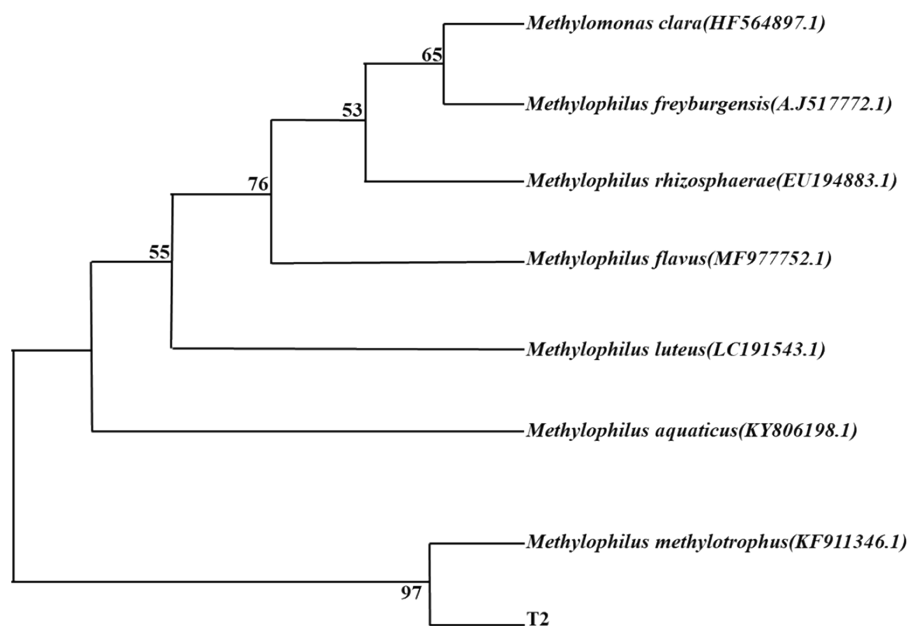


Fig. S3:

