***Supporting information***

**Self-assembled oil palm biomass-derived modified graphene oxide anode: An efficient medium for energy transportation and bioremediating Cd (II) via microbial fuel cells**

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**Fig. S1:** EDX analysis of (a) L-GO and (b) L-GO/ZnO composite.



**Fig. S2:** Atomic force microcopy micrographs of (a) L-GO and (b) L-GO/ZnO composite.



**Fig. S3:** Results of **(a)** thermal gravimetric analysis and **(b)** tensile compression assay for the treated L-GO and L-GO–ZnO anodes.

**Table S1:** List of identified bacteria species from clone libraries of L-GO and L-GO/ZnO anode biofilm

|  |  |  |  |
| --- | --- | --- | --- |
| Bacteria species | Query cover (%) | Identity (%) | Accession number1(6S rRNA Gene) |
| L-GO anodic bacterial species in synthetic Cd (II)-based wastewater | | | |
| *Lysinibacillus fusiformis*  strain DSM 2898 | 100 | 95.7 | NR-042072.1 |
| *Lysinibacillus fusiformis* strain NBRC15717 | 100 | 95.77 | NR-112569.1 |
| *Lysinibacillus mangiferihumi* strain M-GX18 | 100 | 95.69 | NR-118146.1 |
| Lysinibacillus sphaericus strain DSM 28 | 100 | 95.61 | NR-042073.1 |
| *Lysinibacillus sphaericus* strain NBRC 15095 | 100 | 95.61 | NR-112627.1 |
| Lysinibacillus parviboronicapien strain NBRC 103144 | 100 | 95.19 | NR-114213.1 |
| *Bacillus ndiopicus* starin FF3 | 100 | 93.88 | NR-149205.1 |
| *Bacillus cecembensis* strain PN5 | 100 | 93.71 | NR-042648.1 |
| Solibacillus isronensis B3W22 | 100 | 93.30 | NR-115952.1 |
| Solibacillus isronensis B3W22 | 100 | 93.20 | NR-118049.1 |
| Psychrobacillus lasiicapitis strain NEAU-3TGS17 | 98 | 90.83 | NR-159144.1 |
| Viridibacillus arvi strain LMG 22165 | 98 | 90.71 | NR-025627.1 |
| *Citrobacter youngae* strain GTC 1314 | 88 | 83.1 | NR-041527.1 |
| Escherichia coli strain NBRC 102203 | 88 | 82.22 | NR-114042.1 |
| Escherichia coli strain U 5/41 | 88 | 82.22 | NR-024570.1 |
| Klebsiella pneumoniae strain ATCC1884 | 88 | 82.1 | NR-117684.1 |
| Enterobacter spp. ATTC BAA-2102 | 99 | 82 | NR-117547.1 |
| L-GO/ZnO composite anodic bacterial species in synthetic Cd (II)-based wastewater | | | |
| *Lysinibacillus fusiformis*  strain DSM 2898 | 100 | 95.7 | NR-042072.1 |
| *Lysinibacillus fusiformis* strain NBRC15717 | 100 | 95.77 | NR-112569.1 |
| *Chrysecobacterium gleum* strain NBRC 15054 | 99 | 95.07 | NR-113722.1 |
| *Chryseobacterium indologenes* NBRC 14944 | 99 | 95.15 | NR-112975.1 |
| *Bergeyella zoohelcum* strain D658 | 99 | 91.2 | NR-104718.1 |



**Fig. S4:** EDX analysis of (a) treated L-GO and (b) treated L-GO/ZnO composite.

**Table S2:** A comparative profile on the removal of toxic metals via MFC with different anodes.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Metals | Initial concentration (ppm) | Anode material | Cathode material | Inoculation source | Organic substrate | Removal efficiency (%) | Reference |
| Cr (VI) | 20 | Graphite felt | Graphite felt | Anaerobic digester sludge | Glucose | 79 | (Wu et al., 2015) |
| Cr (VI) | 100 | Non-wet proof plain carbon cloth | Non-wet proof plain carbon cloth | Anaerobic sludge | - | 99 | (Gangadharan and Nambi, 2015) |
| Cd (II) | 100 | Graphite granules | Carbon felt | Contaminated soil | Sodium acetate | 31 | (Habibul et al., 2016) |
| Pb (II) | 900 | Graphite granules | Carbon felt | Contaminated soil | Sodium acetate | 44.1 | (Habibul et al., 2016) |
| V(V) | 200 | Carbon fiber felt | Carbon fiber felt | *Dysgonomonas and Klebsiella* | Acetate | 60.7 | (Qiu et al., 2017) |
| Cd(II) | 50 | Graphite felt | Graphite felt | Mixed microbial culture | Acetate | 60 | (Gai et al., 2018) |
| Hg(II) | 25 | Graphite felt | Graphite felt | Mixed microbial culture | Acetate | 55 | (Gai et al., 2018) |
| Ni (II) | 32 | Graphite felt | Graphite felt | Mixed microbial culture | Sodium acetate | 95 | (Li et al., 2019) |
| Cr (VI) | 100 | Graphite plate | Graphite plate | Anaerobic sludge bed | Sodium acetate | 82 | (Li et al., 2019) |
| Cr (VI) | - | Graphite brushes | Carbon cloth | Anaerobic sludge | Glucose | 99 | (Wang et al., 2020) |
| U(VI) | 680 | Graphite felt | Graphite felt | Nuclear waste sludge | Acetate | 90 | (Vijay et al., 2020) |
| Cu (II) | 500 | Carbon felt | Carbon felt | Soil sludge | Glucose | 94 | (Zhang et al., 2020) |
| Pb (II) | 50 | Graphene oxide | Graphite rod | Wastewater | Sweat potatoes wastes | 60.33 | (Yaqoob et al., 2021) |
| Cd (II) | 50 | Graphene oxide/PANI | Graphite rod | Wastewater | Sweat potatoes wastes | 65.51 | (Yaqoob et al., 2021) |
| Cd (II) | 100 | L-GO | Graphite rod | Wastewater | Oil palm trunk sap | 83.50 | **Present work** |
| Cd (II) | 100 | L-GO-ZnO | Graphite rod | Wastewater | Oil palm trunk sap | 90.00 | **Present work** |

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