Supplementary Information (SI) for ChemComm.

Supplementary Information for

Metal-Organic Frameworks as Advanced Platforms for Radionuclide Detection†

Yunyi Cui and Jian Lin*

School of Nuclear Science and Technology, Xi'an Jiaotong University, No.28, West Xianning Road, Xi'an, 710049, P. R. China.

** Corresponding Author, E-mail: jianlin@xjtu.edu.cn*

Abbreviations

4-Mpy: 4-Mercaptopyridine
4,4'-Azbpy: 4,4'-Azobipyridine
AG: Alginate gel
Bce: 1,2-Bis(4-carboxyphenoxy)-ethane
BDAT: 4,4′,4″,4‴-([1,1′-Biphenyl]-4,4′-diylbis(azanetriyl))tetrabenzoic acid
Bdc: Dicarboxylate
BDC-OH: 2-Hydroxyterephthalic acid
Bipy: 4,4'-Bipyridine
BITD: 5'-(4,5-bis(4-carboxyphenyl)-1*H*-imidazol-2-yl)[1,1':3',1"-terphenyl]-4,4"-dicarboxylic acid
Bpdc: Biphenyl-4,4'-dicarboxylate
Bpe: 1,2-Bis(4-pyridyl)ethylene
Bppt: 4-Amino-3,5-bis(4-pyridyl-3-phenyl)-1,2,4-triazole
Bpy: 2,2′-Bipyridine
Bpydc: 2,2'-Bipyridine-5,5'-dicarboxylic acid
BTC: 1,3,5-benzene tricarboxylic acid
CA: Competitive absorption
Cada: 9-(4-Carboxy-phenyl)-9*H*-carbazoly-3,6-dicarboxylic acid
CH_3CN: Acetonitrile
COFs: covalent-organic frameworks
Cpia: 5-(4-Carboxyphenoxy)isophthalic acid
CT: Charge transfer
Cyh: Cyclohexane
DATP: Diaminoterephthalic acid
DATRz: 3,5-Diamino-1,2,4-triazole
DBIIA: 5-(1,3-Dioxo-1*H*-benzo[de]isoquinolin-2(3*H*)-yl)isophthalic acid
DBT: 4,4′-Di(4*H*-1,2,4-triazol-4yl)-1,1′-biphenyl
Dcbpy: 4,4′-Dicarboxylate-2,2′-dipyridine anion
DHTA: 2,5-Dihydroxybenzene-1,4-dicarboxylic acid
DL-lac: Lactate anion
DMA: N,N-dimethylacetamide
DMF: N,N-dimethylformamide
Dmimpym: 4,6-Di(2-methyl-imidazol-1-yl)-pyrimidine
DMSO: Dimethyl sulfoxide
DOG: Dissolved off-gas
DPA: Dicarboxy-9,10-diphenylanthracene
DPV: differential pulse voltammetry
DR: Dissolution-recrystallization

Ebic: 2-Ethyl-1*H*-benzo[d]imidazole-5-carboxylic acid
EIS: Electrochemical impedance spectroscopy
ET: Energy transfer
FDC: 2,5-Furandicarboxylic acid
FRET: Förster Resonance Energy Transfer
GCE: Glassy carbon electrodes
Hcpcp: Hexakis(4-carboxylatophenoxy)cyclotriphosphazene
Hipamifba: 4-(((4-((carboxymethyl)carbamoyl)phenyl)amino)methyl)benzoic acid
HOFs: Hydrogen-bonded organic frameworks
ICP-MS: Inductively coupled plasma mass spectrometry
IDE: Interdigitated comblike electrode
Imdc: Imidazole-4,5-dicarboxylic acid
Ina: Isonicotinate
IX: Ion exchange
K_{SV}: Quenching constant
LOD: Limit of detection
LSV: linear sweep voltammetry
LTP: Low-temperature NH_3 plasma
MAs: Minor actinides
MeOH: methanol
MOFs: Metal-organic frameworks
Mpy: Mercaptopyridine
MTBC: [1,1'-biphenyl]-4-carboxylic acid
Nda: 1,4-Naphthalenedicarboxylic acid
NH_2-BDC: 2-Aminobenzene-1,4-dicarboxylic acid
NI-bpy-44: N-(pyridin-4-yl)-4-(pyridin-4-yl)-1,8-naphthalimide
NPYC: N-pyridin-4-ylpyridine-4-carboxamide
P4b: Tetra(pyridin-4-yl)benzene
PABA: P-aminobenzoic acid
PAF: Porous aromatic framework
PATP: 2-((Pyridin-1ium-2-ylmethyl)ammonio)terephthalate)
PB: Prussian blue
PDA: 1,4-Phenylenediacetate
PET: Photoinduced electron transfer
Pia: 5-(Pyridin-4-yl)isophthalic acid
PMA: Pyromellitic acid
Ppb: Parts-per-billion
PPh_3: Triphenylphosphine
PPPy: Polyphosphonated pyridyl

Ppy: 2-Phenylpyridine
PQTB: 4,4’,4’’,4’’’-(Pyrazino[2,3-*g*]quinoxaline-2,3,7,8-tetrayl)tetrabenzoic
PVTP: 2-Vinyl terephthalic acid
Pybz: 4-Pyridylbenzoate
REEs: Rare earth elements
RGB: Red green blue
Sal: Salicylaldehyde
SC: Structure collapse
SC-SC: Single-crystal-to-single-crystal
SERS: Surface-enhanced Raman scattering
SNF: Spent nuclear fuel
SQ: Static quenching
TATAB: 2,4,6-Tri[(pcarboxyphenyl) amino]-1,3,5-triazine
TATIB: 2,2’,2’’-([1,3,5]-Triazine-2,4,6-triimino)tribenzoic acid
TBT: 1,3,5-Benzenetrisbenzoate
TCBPA: Tris(4’-carboxybiphenyl)amine
Tcbpp: 2,4,6-Tris(1-(4-carboxylatobenzyl)pyridinium-4-yl)pyridine
TCPE: Tetrakis(4-carboxyphenyl)ethylene acid
TCPP: Tetras-(4-carboxyphenyl) porphyrin
TDA: Thiodiglycolic acid
TDPAT: 5,5’,5’’-(1,3,5-Triazine 2,4,6-triyltriimino)tris[1,3-benzenedicarboxylic acid]
TIBTC: 2,4,6-Triiodo-1,3,5-benzene tricarboxylic acid
Tipa: Tris (4-(1*H*-imidazole-1-yl) phenyl) amine
TOCNF: TEMPO-oxidized cellulose nanofibers
TP: 2’,5’-dimethyl-[1,1’:4’,1’’-terphenyl]-4,4’’-dicarboxylate
TPE: 1,1,2,2-Tetrakis(4-carboxy) ethene
TPPYE: Tetrakis(4-pyrimidylphenyl)ethene
TTHA: 1,3,5-Triazine-2,4,6-triamine hexaacetic acid
Tz: 1,2,4-Triazolate
U.S. EPA: United States Environmental Protection Agency
WHO: World Health Organization
ZIF: Zeolitic imidazolate framework

Supplementary Tables

Table S1. Examples of MOFs for the detection of I_2.

No.	MOFs	Radionuclide	Detection method	LOD	Solvent	Mechanism	Refs.
1	$\{[Zn_3(DL\text{-}lac)_2(pybz)_2]\cdot 2.5DMF\}_n$	I_2	Direct measurement	/	Cyh	SC-SC and CT	S1
2	$[Cu_6(pybz)_8(OH)_2]\cdot I_5^-\cdot I_7^-$	I_2	Direct measurement	/	Cyh	SC-SC and CT	S2
3	$\{[Zn(ebic)_2]\}_n$	I_2	Direct measurement	/	Cyh	CT	S3
4	ZIF-70@IDE	I_2	EIS	467.6 μg/kg	Vapor	CT	S4
5	ZIF-8-coated IDEs	I_2	EIS	/	Vapor	CT	S5
6	MFM-300(X) (X = Al, Fe, In, or Sc)	I_2	EIS	/	Vapor	CT	S6
7	Ln-BTC (Ln = Eu, Tb, Dy, Er, or Yb)	I_2	EIS	/	Vapor	CT	S7
8	$Tb(Cu_4I_4)(ina)_3(DMF)$	I_2	LSV	0.01 g/L	Vapor	CT	S8
9	Ln-BTC (Ln = Eu or Tb)	I_2	Turn off	/	Vapor	PET	S7
10	$Cd_2(BDC)_2(NI\text{-}bpy\text{-}44)_2$ (1)	I_2	Turn off	/	Vapor	CT	S9
11	$Cd_2(BDC\text{-}Br)_2(NI\text{-}bpy\text{-}44)_2$ (2)						
12	$Cd_2(BDC\text{-}NO_2)_2(NI\text{-}bpy\text{-}44)_2$ (3)						
13	$Cd_2(bpdc)_2(NI\text{-}bpy\text{-}44)_2$ (4)						
14	$Cd(bppt)_2(ClO_4)_2\cdot H_2O$	I_2	Turn off	/	EtoH	Interaction	S10
15	$[Pb_6(\mu_4\text{-}O)_2(pia)_4]\cdot 4DMF$	I_2	Turn off	/	Vapor/ Water	Interaction and ET	S11
16	$Ag(4\text{-}Mpy)_2(PPh_3)_2$ (MSOF-1)	I_2	Turn off	/	Vapor	CT	S12
17	MIL-53(Al)-TDC	I_2	Fluorochromic	2 wt%	Vapor	ET	S13
18	ZIF-90	I_2	Colorimetric	/	Vapor	CT	S14

Table S2. Examples of MOFs for the detection of UO_2^{2+}.

No.	MOFs	Radionuclide	Detection method	K_{SV} (M^{-1})	LOD (g/L)	LOD (M)	Solvent	Mechanism	Refs.
1	$[Tb_4(C_{29}O_8H_{17})_2(NO_3)_4(DMF)_4(H_2O)_4]\cdot 4H_2O\cdot 8.5DMF$ (YTU-100)	UO_2^{2+}	Turn off	8.10×10^4	7.50×10^{-7}	2.78×10^{-9}	Water	FRET	S15
2	$[Tb(BPDC)_2\cdot(CH_3)_2NH_2$ (DUT-101)	UO_2^{2+}	Turn off	1.03×10^4	8.34×10^{-6}	3.10×10^{-8}	Water	FRET and CT	S16
3	$[EuNa_{0.5}(bce)_2]\cdot Na_{0.5}\cdot DMF\cdot 3.5H_2O$	UO_2^{2+}	Turn off	3.66×10^4	1.34×10^{-5}	4.97×10^{-8}	Water	CA and ET	S17
4	$[Eu_2(NH_2\text{-}BDC)_{2.5}(CH_3COO)(DMA)(H_2O)]\cdot DMA$@Sal	UO_2^{2+}	Turn off	6.70×10^2	3.51×10^{-3}	1.30×10^{-5}	Water	CA	S18
5	$[Co_2(dmimpym)(nda)_2]_n$	UO_2^{2+}	Turn off	1.10×10^4	3.56×10^{-3}	1.32×10^{-5}	DMF	CT	S19
6	$[Eu_2(MTBC)(OH)_2(DMF)_3(H_2O)_4]\cdot 2DMF\cdot 7H_2O$	UO_2^{2+}	Turn off	3.63×10^3	3.09×10^{-4}	1.14×10^{-6}	DMF/H_2O (v/v= 1/1)	ET and CA	S20
7	$[Eu_2(TATAB)_2]\cdot 4H_2O\cdot 6DMF$	UO_2^{2+}	Turn off	8.40×10^4	2.43×10^{-4}	9.00×10^{-7}	DMF	CT and ET	S21
8	$[Eu(TIBTC)(DMF)_3]_n$	UO_2^{2+}	Turn off	4.00×10^3	5.54×10^{-3}	1.10×10^{-5}	Water	CT and ET	S22
9	TOCNF@Eu-MOF	UO_2^{2+}	Turn off	8.21×10^4	3.56×10^{-4}	1.32×10^{-6}	Water	Interaction and ET	S23
10	$[In_2(OH)_2(H_2TTHA)(H_2O)_2]_n$	UO_2^{2+}	Turn off	4.80×10^4	4.20×10^{-4}	1.56×10^{-6}	Water	Interaction	S24
11	$Zr_6O_4(OH)_4(OH)_6(H_2O)_6(TCPE)_{1.5}\cdot(H_2O)_{24}(DMF)_9$ (Zr-TCPE)	UO_2^{2+}	Turn off	3.78×10^3	6.70×10^{-7}	2.48×10^{-9}	Water	CA	S25
12	$\{[Me_2NH_2]_{0.5}[Co(DATRz)_{0.5}(NH_2BDC)]\cdot xG\}_n$	UO_2^{2+}	Turn off	7.95×10^4	3.09×10^{-5}	1.30×10^{-7}	Water	IX and FRET	S26
13	UiO-66-NH_2	UO_2^{2+}	Turn off	9.94×10^4	5.40×10^{-5}	2.00×10^{-7}	Water	Interaction and SQ	S27
14	LTP@UiO-66-NH_2	UO_2^{2+}	Turn off	1.81×10^5	2.16×10^{-5}	8.00×10^{-8}			
15	$Zn_2(PMA)(NPYC)(H_2O)_2\cdot 2H_2O$ (HNU-50)	UO_2^{2+}	Turn off	/	3.24×10^{-6}	1.20×10^{-8}	Water	Interaction and CA	S28
16	Tb-MOF-76	UO_2^{2+}	Turn off	/	5.40×10^{-1}	2.00×10^{-3}	Water	Interaction and ET	S29

17	ZIF-90-PABA-Eu	UO_2^{2+}	Turn off	/	1.50×10^{-5}	5.56×10^{-8}	Water	CA and SQ	S30
18	[Tb(1,3,5-benzenetrisbenzoate)]$_n$ (Tb-TBT)	UO_2^{2+}	Turn off	/	2.03×10^{-7}	7.50×10^{-10}	Water	ET	S31
19	Tb-TATAB	UO_2^{2+}	Turn off	/	9.00×10^{-7}	3.33×10^{-9}	Water	Interaction and ET	S32
20	Tb@MOF-808-TDA	UO_2^{2+}	Turn off	/	8.20×10^{-5}	3.04×10^{-7}	Water	PET	S33
21	Tb-MOF/Tb-AG	UO_2^{2+}	Turn off	/	1.20×10^{-9}	4.44×10^{-12}	Water	IX	S34
22	Tb-TDPAT	UO_2^{2+}	Turn off	/	3.38×10^{-7}	1.25×10^{-9}	Water	ET	S35
23	$Zn_4(Hcpcp)(OH)_2(H_2O)_4$	UO_2^{2+}	Turn off	7.44×10^{3}	/	/	Water	CT	S36
24	$Cd_3(Cada)_2(bipy)(H_2O)_2\cdot H_2O$	UO_2^{2+}	Turn off	2.67×10^{4}	/	/	Water	FRET	S37
25	$C_{40}H_{22}N_4O_8Cd$ (HUST-36)	UO_2^{2+}	Turn off	2.00×10^{5}	/	/	Water	CT	S38
26	IHEP-24	UO_2^{2+}	Turn off	1.25×10^{2}	/	/	Water	CT	S39
27	Eu-PPPy	UO_2^{2+}	Turn on	/	3.24×10^{-3}	1.20×10^{-5}	Water	FRET	S40
28	$UO_2(O_2)_{0.5}(DPA)]$ $[H_2N(CH_3)_2$ (ECUT-177)	UO_2^{2+}	Turn on	/	6.59×10^{-7}	2.44×10^{-9}	Water	Interaction and IX	S41
29	C-GSH-AuNCs@UiO-66-NH_2	UO_2^{2+}	Turn on	/	4.13×10^{-6}	1.53×10^{-8}	Water	CT	S42
30	Eu-DATP	UO_2^{2+}	Fluorochromic	/	7.29×10^{-7}	2.70×10^{-9}	Water	ET	S43
31	UiO-67-bpydc@Eu^{3+}	UO_2^{2+}	Fluorochromic	/	8.10×10^{-7}	3.00×10^{-9}	Water	Interaction and ET	S44
32	ZIF-L-hemin	UO_2^{2+}	Colorimetric	/	1.88×10^{-5}	7.90×10^{-8}	Water	Interaction	S45
33	FA@ZIF-8	UO_2^{2+}	SERS	/	2.70×10^{-5}	1.00×10^{-7}	Water	Interaction	S46
34	PtRu/UiO66-NH_2	UO_2^{2+}	LSV, and DPV	/	5.70×10^{-6}	2.40×10^{-9}	Water	CT	S47

Table S3. Examples of MOFs for the detection of Th^{4+}.

No.	MOFs	Radionuclide	Detection method	K_{SV} (M^{-1})	LOD (g/L)	LOD (M)	Solvent	Mechanism	Refs.
1	$[Eu_2(NH_2\text{-}BDC)_{2.5}(CH_3COO)(DMA)(H_2O)]\cdot DMA$@Sal	Th^{4+}	Turn off	7.52×10^{3}	2.69×10^{-4}	1.16×10^{-6}	Water	CA	S18
2	$[Eu_2(FDC)_3(DMA)_2]\cdot 4H_2O$	Th^{4+}	Turn off	6.68×10^{4}	8.10×10^{-3}	3.49×10^{-5}	Water	FRET and CA	S48
3	DBT-DHTA-Cd	Th^{4+}	Turn off	/	8.00×10^{-5}	1.67×10^{-7}	Water	PET	S49
4	$[Eu_2(MTBC)(OH)_2(DMF)_3(H_2O)_4]\cdot 2DMF\cdot 7H_2O$ (ThP-1)	Th^{4+}	Fluorochromic	/	2.42×10^{-5}	1.04×10^{-7}	Water	Adsorption and CT	S50
5	$Eu_xTb_{1\text{-}x}$-BDC-OH	Th^{4+}	Fluorochromic	/	6.11×10^{-4}	2.63×10^{-6}	DMF	DR	S51

Table S4. Examples of MOFs for the detection of Cs^{+} and Sr^{2+}.

No.	MOFs	Radionuclide	Detection method	K_{SV} (M^{-1})	LOD (g/L)	LOD (M)	Solvent	Mechanism	Refs.
1	Cd-PQTB (HUST-31)	Cs^{+}	Turn on	/	2.66×10^{-2}	2×10^{-4}	Water	CT	S52
2	Zn-TPE-PB (PB-COP)	Cs^{+}	Turn off	/	7.38×10^{-5}	5.5×10^{-7}	ethanol	SC and PET	S53
1	Al-TATIB	Sr^{2+}	Turn on	-8.35×10^{3}	4.7×10^{-4}	5.37×10^{-6}	DMF	CT	S54
2	$Mg(DBIIA)(DMSO)_2$ (1)				6.08×10^{-4}	6.94×10^{-6}			
3	$Mn(DBIIA)(DMSO)_2$ (2)				2.54×10^{-5}	2.9×10^{-7}			
4	$Mg_{0.89}Mn_{0.11}(DBIIA)(DMSO)_2$ (3)	Sr^{2+}	Turn on	/	1.49×10^{-4}	1.7×10^{-6}	EtOH	DR	S55
5	$Mg_{0.75}Mn_{0.25}(BBIIA)(DMSO)_2$ (4)				5.69×10^{-5}	6.5×10^{-7}			
6	$Mg_{0.37}Mn_{0.63}(DBIIA)(DMSO)_2$ (5)				3.24×10^{-5}	3.7×10^{-7}			
7	Al-TCPP	Sr^{2+}	LSV	/	2.63×10^{-9}	3×10^{-11}	Water	Interaction	S56

Table S5. Examples of MOFs for the detection of $ReO_4^–$.

No.	MOFs	Rddion uclide	Detection method	K_{SV} (M^{-1})	LOD (g/L)	LOD (M)	Solvent	Mechanism	Refs.
1	$[Zr_6O_4(OH)_4(NH_3^+$ $-BDC)_6]Cl_6·xH_2O$ (MOR-1)	$ReO_4^–$	Turn off	/	$3.6×10^{-4}$	$1.44×10^{-6}$	Water	CT	S57
2	$H_{16}[Zr_6O_{16}(H_2PATP)_4]Cl_8·xH_2O$ (MOR-2)				$2×10^{-4}$	$8×10^{-7}$			
3	$\{[Cu(hipamifba)(4,4′-azbpy)]·2CH_3OH·2H_2O\}_n$ (1)	$ReO_4^–$	Turn off	$3.16×10^6$	$3.4×10^{-3}$	$1.36×10^{-5}$	Water	PET and SQ	S58
4	$\{[Zn(hipamifba)(4,4′-azbpy)]·2CH_3OH·2H_2O\}_n$ (2)			$3.05×10^6$	$5.4×10^{-3}$	$2.16×10^{-5}$			
5	[Ag(1,2,4,5-p4b)](SbF_6) (TJNU-302)	$ReO_4^–$	Turn off	$3.47×10^3$	$2.25×10^{-2}$	$9×10^{-5}$	Water	CT	S59
6	Ag_3Tipa_2 (NCU-2)	$ReO_4^–$	Turn off	/	$1.67×10^{-5}$	$6.67×10^{-8}$	Water	Adsorption, CT, and IX	S60
7	Ir-$(ppy)_2(bpy)^+$-PAF (Ir-PAF)	$ReO_4^–$	Turn on	/	$5.569×10^{-4}$	$2.23×10^{-6}$	Water	Interaction and IX	S60
8	Ag-TPPYE (ZJU-X8)	$ReO_4^–$	Fluorochromic	/	$1.02×10^{-2}$	$4.08×10^{-5}$	Water	CT and IX	S61

Table S6. Examples of MOFs for the detection of I^- and IO_3.

No.	MOFs	Rddion uclide	Detection method	K_{SV} (M^{-1})	LOD (g/L)	LOD (M)	Solvent	Mechanism	Refs.
1	$Zr_6O_4(OH)_4(OH)_6(H_2O)_6(TCPE)_{1.5}\cdot(H_2O)_{24}(DMF)_9$ (Zr-TCPE)	I^-	Turn off	2.92×10^3	8.7×10^{-7}	6.86×10^{-9}	Water	ET	S25
2	$Cd_{2.5}(PDA)(tz)_3$	I^-	Turn off	1.8×10^4	8×10^{-5}	6.3×10^{-7}	Water	CA	S62
3	$[Tb(cpia)(H_2O)_2]_n\cdot nH_2O$	I^-	Turn off	1.23×10^4	2.9×10^{-4}	2.29×10^{-6}	Water	CA	S63
4	$[Eu_2Zn(dcbpy)_3(H_2O)_4](NO_3)_2\cdot12H_2O_n$ ($1\cdot NO_3^-$)	I^-	Turn off	2.3×10^4	6×10^{-5}	4.73×10^{-7}	Water	CT and CA	S64
5	$[Tb_2Zn(dcbpy)_3(H_2O)_4](NO_3)_2\cdot12H_2O_n$ ($2\cdot NO_3^-$)			1.8×10^5	1×10^{-6}	7.88×10^{-9}			
6	$Eu_4(\mu_3\text{-}OH)_4(tcbpp)_2(H_2O)_9\cdot Cl_2$	I^-	Turn off	/	/	/	Water	CT	S65
7	$\{[Zn_4Eu_2(imdc)_4(SO_4)(H_2O)_8]\cdot4H_2O\}_n$	I^-	Turn off	/	/	/	DMF	Interaction	S66
8	LVMOF-1-Cl	I^-	Turn off and colorimetric	/	/	/	Water	FRET	S67
9	$Co_2(bpe)_{2.5}(NO_3)_4(CH_3O)$ (Co-bpe)	I^-	Turn off and colorimetric	6.64×10^3	3.43×10^{-5}	2.7×10^{-7}	MeOH	CT	S68
10	Tb@Cu-BTC	I^-	Turn on	/	5.96×10^{-4}	4.7×10^{-6}	Water	Guest-induced emission	S69
11	$[Dy(cpia)(H_2O)_2]_n\cdot nH_2O$	I^-	Fluorochromic	1.17×10^4 (574 nm)	3.05×10^{-6}	2.4×10^{-8}	Water	CA	S70
1	$[Th_6(\mu_3\text{-}OH)_8(H_2O)_3(DMF)(TCBPA)_4(HCOO)_2]\cdot(NO_3)_2$ (Th-SINAP-200)	IO_3^-	Turn off	2.2×10^4	1.07×10^{-7}	6.12×10^{-10}	Water	SC-SC and ET	S71
2	$[Th_6(\mu_3\text{-}O)_4(\mu_3\text{-}OH)_4(H_2O)_4(DMF)_2(BDAT)_2(HCOO)_4]\cdot(DMF)_{13}(H_2O)_{24}$ (Th-BDAT)	IO_3^-	Turn off	3.86×10^4	2.39×10^{-4}	1.37×10^{-6}	Water	Adsorption, CA, and ET	S72
3	$[Th_6(\mu_3\text{-}O)_4(\mu_3\text{-}OH)_4(H_2O)_6(BITD$	IO_3^-	Turn off	6.65×10^3	3.53×10^{-4}	2.02×10^{-6}	Water	Adsorption	S73

	$)_2(HCOO)_4]\cdot 39.5DMF\cdot 48.5H_2O$ (Th-BITD-1)							and ET	
4	$[Th_6(\mu_3\text{-}O)_4(\mu_3\text{-}OH)_4(H_2O)_6(BITD)_2(HCOO)_4]\cdot 16DMF\cdot 19H_2O$ (Th-BITD-2)			2.97×10^3	1.84×10^{-3}	1.05×10^{-5}			
5	$[Zr_6(\mu_3\text{–}OH)_4(\mu_3\text{–}O)_4(OH)_4(BITD)_2(H_2O)_4]\cdot(DMF)_6(H_2O)_{20}$ (Zr-BITD)	IO_3^-	Turn off	8.02×10^3	3.59×10^{-4}	2.05×10^{-6}	Water	Adsorption, CA, and ET	S74

Supplementary References

S1. M.-H. Zeng, Q.-X. Wang, Y.-X. Tan, S. Hu, H.-X. Zhao, L.-S. Long and M. Kurmoo, *J. Am. Chem. Soc.*, 2010, **132**, 2561.

S2. Z. Yin, Q.-X. Wang and M.-H. Zeng, *J. Am. Chem. Soc.*, 2012, **134**, 4857.

S3. F. Yu, D.-D. Li, L. Cheng, Z. Yin, M.-H. Zeng and M. Kurmoo, *Inorg. Chem.*, 2015, **54**, 1655.

S4. A. S. Babal, S. Mollick, W. Kamal, S. Elston, A. A. Castrejón-Pita, S. M. Morris and J.-C. Tan, *Mater. Today*, 2022, **58**, 91.

S5. L. J. Small and T. M. Nenoff, *ACS Appl. Mater. Interfaces*, 2017, **9**, 44649.

S6. L. J. Small, R. C. Hill, J. L. Krumhansl, M. E. Schindelholz, Z. Chen, K. W. Chapman, X. Zhang, S. Yang, M. Schroder and T. M. Nenoff, *ACS Appl. Mater. Interfaces*, 2019, **11**, 27982.

S7. X. Dong, Q. He, M. Li, X. Wang, Y. Wang and W. Zhang, *Dalton Trans.*, 2021, **50**, 15567.

S8. Y. Q. Hu, M. Q. Li, Y. Wang, T. Zhang, P. Q. Liao, Z. Zheng, X. M. Chen and Y. Z. Zheng, *Chem. Eur. J.*, 2017, **23**, 8409.

S9. T. C. Chen, M. J. Tsai and J. Y. Wu, *Chem. Eur. J.*, 2018, **25**, 1337.

S10. Q.-K. Liu, J.-P. Ma and Y.-B. Dong, *Chem. Commun.*, 2011, **47**.

S11. Y.-N. Yu, W.-M. Ma, J.-X. Wu, Q. Zhang, J. Zhou, K.-K. Jiang, D.-D. Wang, Y.-K. Li, Y.-M. Ma and Z. Yin, *Chem. Eng. J.*, 2025, **504**, 158782.

S12. Q. Li, W. Guo, Z. Wang, L. L. Tan and L. Shang, *Adv. Funct. Mater.*, 2024, **35**.

S13. M. L. Díaz-Ramírez, B. Vargas, J. Raziel Álvarez, B. Landeros-Rivera, M. Rivera-Almazo, C. Ramos, J. Gabriel Flores, E. Morales, R. Vargas, J. Garza, E. González-Zamora, A. Martínez, D. Solís-Ibarra and I. A. Ibarra, *Dalton Trans.*, 2020, **49**, 6572.

S14. Y. Lei, G. Zhang, Q. Zhang, L. Yu, H. Li, H. Yu and Y. He, *Nat. Commun.*, 2021, **12**.

S15. M. Lei, Y. Jia, W. Zhang, J. Xie, Z. Xu, Y. Wang, W. Du and W. Liu, *ACS Appl. Mater. Interfaces*, 2021, **13**, 51086.

S16. J. Ye, R. F. Bogale, Y. Shi, Y. Chen, X. Liu, S. Zhang, Y. Yang, J. Zhao and G. Ning,

Chem. Eur. J., 2017, **23**, 7657.
S17. F. Guo, X.-L. Han, D.-F. Li, C.-Y. Li, D.-P. Li, Z.-K. Yao, L.-P. Wang and Y.-X. Li, *Chem. Eng. J.*, 2024, **499**.
S18. J.-X. Li, Q.-L. Guan, Z.-X. You, Y. Wang, Z. Shi, Y.-H. Xing, F.-Y. Bai and L.-X. Sun, *Adv. Mater. Technol.*, 2021, **6**.
S19. W.-M. Chen, X.-L. Meng, G.-L. Zhuang, Z. Wang, M. Kurmoo, Q.-Q. Zhao, X.-P. Wang, B. Shan, C.-H. Tung and D. Sun, *J. Mater. Chem. A*, 2017, **5**, 13079.
S20. W. Liu, Y. Wang, L. Song, M. A. Silver, J. Xie, L. Zhang, L. Chen, J. Diwu, Z. Chai and S. Wang, *Talanta*, 2019, **196**, 515.
S21. L. Li, S. Shen, J. Su, W. Ai, Y. Bai and H. Liu, *Anal. Bioanal. Chem.*, 2019, **411**, 4213.
S22. Y. Wang, S. H. Xing, X. Zhang, C. H. Liu, B. Li, F. Y. Bai, Y. H. Xing and L. X. Sun, *Appl. Organomet. Chem.*, 2019, **33**.
S23. Y. Deng, S. Jiang, Z. Yan, Y. Chu, W. Wu and H. Xiao, *Anal. Chim. Acta*, 2024, **1292**.
S24. N. Du, J. Song, S. Li, Y. X. Chi, F. Y. Bai and Y. H. Xing, *ACS Appl. Mater. Interfaces*, 2016, **8**, 28718.
S25. Z.-J. Li, X. Wang, L. Zhu, Y. Ju, Z. Wang, Q. Zhao, Z.-H. Zhang, T. Duan, Y. Qian, J.-Q. Wang and J. Lin, *Inorg. Chem.*, 2022, **61**, 7467.
S26. S. Mondal, A. M. Tedy, S. Chand, R. Sahoo, A. K. Manna and M. C. Das, *Inorg. Chem.*, 2024, **63**, 10403.
S27. J. Liu, X. Wang, Y. Zhao, Y. Xu, Y. Pan, S. Feng, J. Liu, X. Huang and H. Wang, *Anal. Chem.*, 2022, **94**, 10091.
S28. X. Qin, W. Yang, Y. Yang, D. Gu, D. Guo and Q. Pan, *Inorg. Chem.*, 2020, **59**, 9857.
S29. W. Yang, Z. Q. Bai, W. Q. Shi, L. Y. Yuan, T. Tian, Z. F. Chai, H. Wang and Z. M. Sun, *Chem. Commun.*, 2013, **49**, 10415.
S30. D. Mei and B. Yan, *J. Hazard. Mater.*, 2023, **447**.
S31. Y. J. Tong, L. D. Yu, Y. Huang, Q. Fu, N. Li, S. Peng, S. Ouyang, Y. X. Ye, J. Xu, F. Zhu, J. Pawliszyn and G. Ouyang, *Anal. Chem.*, 2021, **93**, 9226.
S32. W. Liu, X. Dai, Z. Bai, Y. Wang, Z. Yang, L. Zhang, L. Xu, L. Chen, Y. Li, D. Gui, J. Diwu, J. Wang, R. Zhou, Z. Chai and S. Wang, *Environ. Sci. Technol.*, 2017, **51**, 3911.
S33. D. Mei and B. Yan, *ACS Appl. Mater. Interfaces*, 2023, **15**, 16882.
S34. A.-Q. Cui, X.-Y. Wu, J.-B. Ye, G. Song, D.-Y. Chen, J. Xu, Y. Liu, J.-P. Lai and H. Sun, *J. Hazard. Mater.*, 2023, **448**.
S35. K. Journal of Analytical ChemistryLi, Y. J. Tong, Q. Liu, S. Peng, X. Gong, D. Wang and Z. Gong, *Chem. Commun.*, 2024, **60**, 6913.
S36. X. Chen, Z.-T. Chen, S.-X. Xu, Y. Chen, J.-P. Tong and B. Li, *CrystEngComm*, 2024, **26**, 3341.
S37. J. Liu, J.-X. Hou, J.-P. Gao, J.-M. Liu, X. Jing, L.-J. Li and J.-L. Du, *Mater. Lett.*, 2019, **241**, 184.
S38. Y.-J. Cheng, Z.-T. Chen, H.-R. Ji, Y. Chen and B. Li, *Inorg. Chem. Front.*, 2024, **11**,

5127.
S39. Z. W. Huang, X. B. Li, L. Mei, Y. Z. Han, Y. T. Song, X. Fu, Z. H. Zhang, Z. J. Guo, J. R. Zeng, F. G. Bian, W. S. Wu, K. Q. Hu and W. Q. Shi, *Adv. Funct. Mater.*, 2024, **34**, 2404126.
S40. P. Harvey, A. Nonat, C. Platas-Iglesias, L. S. Natrajan and L. J. Charbonniere, *Angew. Chem. Int. Ed.*, 2018, **57**, 9921.
S41. Q. Zhang, L. Yang, M. Yin, X. Feng and F. Luo, *Inorg. Chem.*, 2023, **62**, 5892.
S42. H.-B. Peng, H.-R. Nan, S.-Q. Li, Y.-Q. Wang, Z.-M. Dong, Z.-B. Zhang, X.-H. Cao and Y.-H. Liu, *J. Solid State Chem.*, 2024, **334**, 124650.
S43. Y.-J. Tong, L.-D. Yu, X. Gong, L. Wu, Y. Chen, D. Wang, Y.-X. Ye, F. Zhu, Z. Gong, J. Xu and G. Ouyang, *Anal. Chem.*, 2024, **96**, 3070.
S44. J. Zhang, Y. Ren, T. Xia, Y. Du, L. Shao, H. Tang and S. Yang, *Z. Anorg. Allg. Chem.*, 2021, **648**.
S45. Z. Zhou, W. He, H. Chao, H. Wang, P. Su, J. Song and Y. Yang, *Anal. Chem.*, 2022, **94**, 6833.
S46. N. Wang, J. Du, X. Li, X. Ji, Y. Wu and Z. Sun, *Anal. Chem.*, 2023, **95**, 12956.
S47. X. Cao, Y. Sun, Y. Wang, Z. Zhang, Y. Dai, Y. Liu, Y. Wang and Y. Liu, *J. Solid State Electrochem.*, 2020, **25**, 425.
S48. L. Song, W. Liu, Y. Wang, L. Chen, X.-F. Wang and S. Wang, *CrystEngComm*, 2019, **21**, 3471.
S49. A. M. Song, M. J. Yang, Z. Wu, Q. Yang, B. Lin, R. P. Liang and J. D. Qiu, *Adv. Funct. Mater.*, 2024, **34**, 2406932.
S50. W. Liu, X. Dai, Y. Wang, L. Song, L. Zhang, D. Zhang, J. Xie, L. Chen, J. Diwu, J. Wang, Z. Chai and S. Wang, *Environ. Sci. Technol.*, 2019, **53**, 332.
S51. Y. Cui, H. Lu, H. Hou, Y. Bai, J. Yang, Y. Li, J. Qiu, S. Wang and J. Lin, *Angew. Chem. Int. Ed.*, 2024, **136**, e202410453.
S52. A.-G. Liu, X.-Y. Meng, Y. Chen, Z.-T. Chen, P.-D. Liu and B. Li, *ACS Appl. Mater. Interfaces*, 2023, **16**, 669.
S53. H. Namgung, Y. J. Gwon, J. Kim, G. Jang, S. E. Pepper, M. D. Ogden, K. R. Whittle, L. M. Harwood and T. S. Lee, *Polymer*, 2018, **158**, 320.
S54. X. Ma, X. Zhang, L. Han, Z. Hao and S. Yong, *Method. Appl. Fluoresc.*, 2021, **9**, 025007.
S55. P.-P. Zhang, B.-L. Zhang, W.-J. Shi, J. Chen, W.-T. Song, J.-J. Zhang, S. Liu and J. Ni, *Sens. Actuat. B Chem.*, 2024, **413**.
S56. X.-G. Wang, Z.-X. He, D.-F. Ding, X.-Q. Luo, L. Dai, W.-Q. Zhang, Q. Ma, Y. Huang and F. Xia, *J. Electrochem.*, 2024, **30**.
S57. S. Rapti, S. A. Diamantis, A. Dafnomili, A. Pournara, E. Skliri, G. S. Armatas, A. C. Tsipis, I. Spanopoulos, C. D. Malliakas, M. G. Kanatzidis, J. C. Plakatouras, F. Noli, T. Lazarides and M. J. Manos, *J. Mater. Chem. A*, 2018, **6**, 20813.
S58. S. Khan and S. K. Mandal, *ACS Appl. Mater. Interfaces*, 2021, **13**, 45465.

S59. C.-P. Li, H. Zhou, J. Chen, J.-J. Wang, M. Du and W. Zhou, *ACS Appl. Mater. Interfaces*, 2020, **12**, 15246.

S60. D. Xu, L. Chen, X. Dai, B. Li, Y. Wang, W. Liu, J. Li, Y. Tao, Y. Wang, Y. Liu, G. Peng, R. Zhou, Z. Chai and S. Wang, *ACS Appl. Mater. Interfaces*, 2020, **12**, 15288.

S61. K. Kang, X. Dai, N. Shen, R. Xie, X. Zhang, L. Lei, S. Wang and C. Xiao, *Chem. Eur. J.*, 2021, **27**, 5632.

S62. D. K. Singha, P. Majee, S. K. Mondal and P. Mahata, *J. Photoch. Photobio. A*, 2018, **356**, 389.

S63. L.-J. Liu, M.-Y. Zhang, Q.-Z. Guo, Z.-H. Zhang and J.-F. Guo, *Dalton Trans.*, 2021, **50**, 1697.

S64. P.-W. Shi, H.-C. Hu, Z.-Y. Zhang, G. Xiong and B. Zhao, *Chem. Commun.*, 2015, **51**, 3985.

S65. M.-Y. Guo, P. Li, S.-L. Yang, R. Bu, X.-Q. Piao and E.-Q. Gao, *ACS Appl. Mater. Interfaces*, 2020, **12**, 43958.

S66. Y.-J. Ding, T. Li, X.-J. Hong, L.-C. Zhu, Y.-P. Cai, S.-M. Zhu and S.-J. Yu, *CrystEngComm*, 2015, **17**, 3945.

S67. T. Gong, Q. Sui, P. Li, X. F. Meng, L. J. Zhou, J.-Q. Chen, J.-H. Xu, L. Wang and E. Q. Gao, *Small*, 2019, **15**, 1803468.

S68. D. Rani, K. K. Bhasin and M. Singh, *Dalton Trans*, 2021, **50**, 13430.

S69. X.-Y. Zhong, C.-H. Li, H.-J. Chen and P.-C. Deng, *Microchem. J.*, 2024, **202**.

S70. Q.-Z. Guo, F.-Y. Yi, M.-Y. Zhang, J.-F. Guo and F.-L. Luo, *Dalton Trans.*, 2023, **52**, 6061.

S71. Z.-J. Li, M. Lei, H. Bao, Y. Ju, H. Lu, Y. Li, Z.-H. Zhang, X. Guo, Y. Qian, M.-Y. He, J.-Q. Wang, W. Liu and J. Lin, *Chem. Sci.*, 2021, **12**, 15833.

S72. Y. Ju, Z.-J. Li, J. Qiu, X. Li, J. Yang, Z.-H. Zhang, M.-Y. He, J.-Q. Wang and J. Lin, *Inorg. Chem.*, 2023, **62**, 8158.

S73. Y. Ju, Z.-J. Li, X. Wang, J. Qiu, Y. Chan, Z.-H. Zhang, M. He and J. Lin, *Chin. J. Chem.*, 2024, **42**, 20.

S74. Y. Lv, Z. Li, Y. Huang, X. Wang, Y. Ju, W. Zhu, Z.-J. Li, L. Zhang and J.-Q. Wang, *J. Organomet. Chem.*, 2024, **1003**.