Electronic Supplementary Material (ESI) for Environmental Science: Processes & Impacts.

Supporting information

Probing interactions of organic molecules, nanomaterials, and microbes with solid surfaces using quartz crystal microbalance: Methodology, advantages, and limitations

Rixiang Huang[1,*], Peng Yi[2], and Yuanzhi Tang[1]

1. School of Earth and Atmospheric Sciences, Georgia Institute of Technology 311 Ferst Dr, Atlanta, Georgia 30324-0340, USA
2. Department of Civil, Environmental and Geomatics Engineering, Florida Atlantic University, Boca Raton, FL 33431-6496, USA

Content:

Table S1. Summary of organics sorption studies using QCM.

Category	Sorbate		Surface	Test conditions	Type of experiments	Ref.
Organics	Polysacharides	Alginate	Silica	pH =5.5-5.7, KCl and $CaCl_2$	Affinity and adlayer viscoelasticity	1
		Alginate	SAMs	pH = 6.0, NaCl and $CaCl_2$	Sorption kinetics and amount, adlayer viscoelasticity	2, 3
		Dextran	Silica, alumina	pH = 6.0, NaCl	Sorption amount and adlayer viscoelasticity	4
		Lipids and polysaccharides	Silica, Polyamide	NaCl	Sorption amount and adlayer characteristics	5
	Nucleic acids	Plasmid DNA	Silica	pH= 5-8, NaCl, Ca, Mg, Cu, Co, or Zn chlorides	Sorption and desorption, kinetics, affinity, adlayer characteristics	6-8
		Plasmid DNA	NOM-coated silica	pH = ~6 NaCl and $CaCl_2$	Sorption and desorption, kinetics, affinity, adlayer characteristics	9, 10
		Plasmind DNA	Silica, alumina	pH = 6, NaCl, sodium sulfate and phosphate	Kinetics	11
		Chromosomal DNA	Bare and NOM-coated silica	NaCl and $CaCl_2$	Kinetics, affinity, adlayer characteristics	12, 13
		RNA	Silica	pH = 6-8, NaCl and $CaCl_2$	Sorption and desorption kinetics	14
	Protein	Cry1Ab, BSA and lysozyme	Silica and poly-L-lysine	pH=5-8, 10 to 50 mM NaCl	Sorption kinetics and affinity	15, 16
		Cry1Ab, BSA and lysozyme	NOM-coated silica, bare Au, silica, polystyrene	pH=5-8, 10 to 50 mM NaCl	Sorption and desorption kinetics and affinity	17, 18
		Prion protein	Silica, alumina	pH=6-7, NaCl	Kinetics and adlayer characteristics	19
		BSA	SAMs, Silica, PVDF	NaCl and $CaCl_2$	Sorption amount	2, 20, 21
		lysozyme, trypsin, and ribonuclease A	NOM	pH=6-8, NaCl	Sorption kinetics and affinity	22

Table S1 (continued). Summary of organics sorption studies using QCM.

Category	Sorbate		Surface	Test conditions	Type of experiments	Ref.
Organics	NOM	NOM	Alumina	pH=3-8,	Sorption kinetics and affinity, adlayer characteristics	23-26
		Naphthenic Acids	silica, alumina, and calcite	Prepared in *n*-dodecane solution	Sorption isotherm	27
		NOM	SAMs	pH=5-8, NaCl	Sorption amount and adlayer thickness	28
	EPS	*E. coli*, *B. subtilis*, *Pseudomonas sp.*, *Rhodococcus sp.*	Silica	pH = 6-8, NaCl and $CaCl_2$	Sorption kinetics	29
		Membrane bioreactor	Silica	pH = 6-8, NaCl and $CaCl_2$	Sorption kinetics, affinity, adlayer characteristics	30
		E. coli	Bared and NOM coated-silica	pH = 6, NaCl and $CaCl_2$	Sorption kinetics	31
		E. coli	SAMs	PBS	Sorption kinetics and adlayer characteristics	32
		Membrane bioreactor	PVDF	pH = 6-8, NaCl	Sorption kinetics and affinity	33, 34

Table S2. Summary of nanomaterials mobility studies using QCM.

Category	Sorbate		Surface	Test conditions	Type of experiments	Ref.
Nanoparticles	Carbon-based	C60	Bare, alginate- and humic-coated silica	pH=5.2, 5.5, 6.0, 7.8 NaCl, $CaCl_2$, presence of NOM	Kinetics, CCC	35-38
		CNT	Alumina, iron oxide, bared and NOM coated-silica, polystyrene, model cell membrane	pH=4 to 8 NaCl, $CaCl_2$	Deposition and release kinetics, CCC, adlayer characteristics	39-42
		GO	Alumina, iron oxide, bared and NOM coated-silica	pH = 5.5, NaCl, $CaCl_2$, $MgCl_2$	Deposition and release kinetics, CCC, adlayer characteristics	43-45
	Metallic	Ag	Bared and NOM-coated silica	Varying pH, NaCl, $CaCl_2$, seawater	Affinity, kinetics, adlayer characteristics	46-48
		Au	Silica, model cell membrane	NaCl	Kinetics, affinity	49, 50
		Fe^0	Bared and NOM-coated silica	NaCl	Affinity	51
	Oxides	TiO_2	Silica	$NaNO_3$, $Ca(NO_3)_2$ pH = 3, 5, 9	Kinetics	52
		CeO_2	Silica, alumina, iron oxide	pH = 4, 6, 8.5 NaCl	Kinetics	53
		Iron oxides	SAMs, silica, polystyrene	pH=4 to 10	Kinetics, CCC, affinity, adlayer characteristics	54
	Others	CdSe/ZnS	SAMs	pH = 6, 7.5, 9, 11	Isotherm	55
		CdTe	Silica	pH = 5 and 7, KCl, $CaCl_2$,	kinetics	56
		Virus	Bare and NOM-coated silica	NaCl, $CaCl_2$, $MgCl_2$	Deposition kinetics	57-60
		Oocysts	Bare and NOM-coated silica	NaCl, $CaCl_2$, $MgCl_2$	Deposition kinetics	61

Table S3. Summary of microbe-surface interaction studies using QCM.

Category	Sorbate		Surface	Test conditions or variables	Type of experiments	Ref.
Microbes	Initial adhesion	Nonfimbriated and fimbriated *E. coli*	SAMs	pH = 7.1 PBS	Adhesion Kinetics and adlayer characteristics ($\Delta D/\Delta f$, cell normalized ΔD and Δf)	62
		E. coli, *B.subtilis*, *Pseudomonas sp.*, *Rhodococcus sp.*	Silica	pH 6.0 NaCl, $CaCl_2$	Deposition kinetics	63
		Pseudomonas aeruginosa	Alginate coated silica	$CaCl_2$ and $MgCl_2$	Deposition kinetics	64
		Diatom	SAMs	K + Si medium	Adhesion Kinetics and affinity	65
		Streptococcus salivarius	Au	pH 6.8, phosphate buffer	$\Delta D/\Delta f$, cell normalized ΔD and Δf	66, 67
		Pseudomonas aeruginosa	Silica and PVDF	NaCl	$\Delta D/\Delta f$, cell normalized ΔD and Δf	68
		E. coli and *Sphingomonas*	Silica	NaCl	Adlayer viscoelasticity ($\Delta D/\Delta f$)	69
		E. coli and *P. aeruginosa*	Glycopolymer	-	Adhesion affinity	70
		B.subtilis	Silica	Extreme Temperature	Adhesion affinity	71
	Biofilm growth	*P. cepacia*	Au	pH 7.2 phosphate buffer	Growth dynamics	72
		Diatom	Au and SAMs	K-medium	Growth dynamics and adlayer viscoelasticity	65, 73
		Pseudomonas aeruginosa	Au	Nutrient conditions, disinfection	Growth dynamics and adlayer viscoelasticity	74
		Streptococcus	Au	Nutrient, flow, and temperature	Growth dynamics and adlayer viscoelasticity	75, 76
		P. putida	silica		Growth dynamics and adlayer viscoelasticity	77
		Pseudomonas fluorescens	Au	Cell concentration, temperature, nutrient,	Growth dynamics	78
		Shewanella	Au	TiO_2 NP	Growth dynamics	79

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