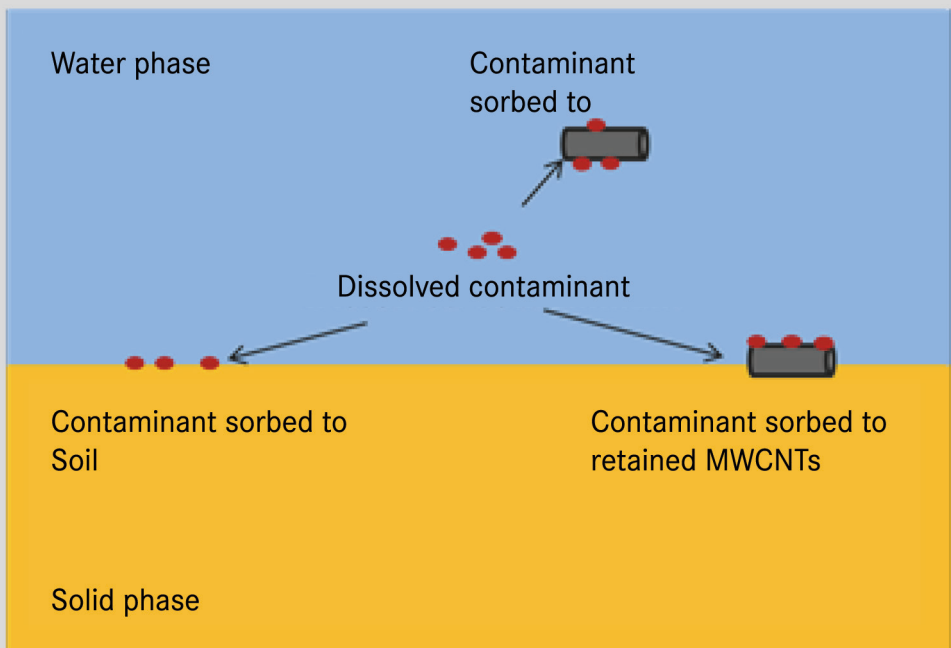


Transport, co-transport, and retention of functionalized multi-walled carbon nanotubes in porous media

Miaoyue Zhang

The interactions between MWCNTs and contaminants in saturated soil



Forschungszentrum Jülich GmbH
Institute of Bio- and Geosciences
Agrosphere (IBG-3)

Transport, co-transport, and retention of functionalized multi-walled carbon nanotubes in porous media

Miaoyue Zhang

Schriften des Forschungszentrums Jülich
Reihe Energie & Umwelt / Energy & Environment

Band / Volume 352

ISSN 1866-1793

ISBN 978-3-95806-198-9

Table of contents

Abstract	I
Zusammenfassung	III
Table of contents	VI
1. Introduction	1
1.1 Carbon nanotubes and their applications	1
1.2 Transport of engineered nanoparticles especially carbon nanotubes in porous media	5
1.3 Co-transport of chemicals by engineered nanoparticles in porous media	7
1.4 The role of soil colloids for engineered nanoparticles transport.....	8
1.5 Chlordecone and sulfadiazine	9
1.6 Objectives of the thesis	11
2. Theoretical background	13
2.1 Transport of engineered nanoparticles in saturated porous media...	13
2.1.1 Stability and aggregation of engineered nanoparticles.....	13
2.1.2 Colloid filtration theory	15
2.1.3 Extension of colloid filtration theory	17
2.2 Colloid-facilitated contaminant transport in saturated porous media	18
3. Materials and methods.....	21
3.1 Carbon nanotubes.....	21
3.2 Chlordecone and sulfadiazine	22
3.3 Surfactants.....	23
3.4 Quartz sand and goethite coated quartz sand.....	25
3.5 Soil	25
3.6 Batch and dialysis adsorption experiments.....	26
3.7 Water-saturated column setup.....	28
3.8 Soil fractionation.....	31
3.9 Numerical modeling.....	32
4. Results and discussion.....	35
4.1 Transport and retention of carbon nanotubes in goethite coated quartz sand.....	35
4.1.1 Characterization of goethite coated sand.....	35
4.1.2 Batch results	36
4.1.3 Effect of mass ratio of goethite in porous media.....	37
4.1.4 Effect of grain size	43

4.2	Transport and retention of carbon nanotubes in soil.....	45
4.2.1	MWCNT suspension stability	45
4.2.2	Zeta potential	45
4.2.3	Transport and Retention of MWCNTs	46
4.2.4	Release of MWCNTs	51
4.2.5	Soil size fractionation	55
4.3	Co-transport of chlordecone and sulfadiazine in the presence of carbon nanotubes in soils	58
4.3.1	Sorption results.....	58
4.3.2	Single-species transport in soil.....	60
4.3.3	Co-transport.....	63
4.4	Outlook: Influence of surfactant on carbon nanotubes transport in porous media	69
4.4.1	Adsorption of surfactants on QS, GQS and MWCNTs.....	69
4.4.2	Transport of surfactant-MWCNTs in quartz sand.....	71
4.4.3	Transport of surfactant-MWCNTs in goethite-coated quartz sand ..	74
5.	Summary and conclusions.....	78
	References	81
	List of Figures	98
	List of Tables	101
	List of Abbreviations	102
	List of Symbols	104
	Curriculum vitae	107
	Publications.....	109
	Acknowledgements.....	111

**Energie & Umwelt /
Energy & Environment
Band / Volume 352
ISBN 978-3-95806-198-9**

