Arsenic removal by the iron oxide sorbent with quaternary ammonium groups modified with lanthanum(III) ions

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How many papers concerning arsenic removal can you find?

Journal of Hazardous Materials 304 (2016) 196–204
Contents lists available at ScienceDirect
Journal of Hazardous Materials
journal homepage: www.elsevier.com/locate/jhazmat

Comparative evaluation of magnetite–graphene oxide and magnetite-reduced graphene oxide composite for As(III) and As(V) removal

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[b] Electronic Materials and Device Research Center, Korea Electronics Technology Institute, 25 Saenari-ro, Bundang-gu, Gyeonggi-do, Seongnam-si 463-816, Republic of Korea
[c] Water Resources and Environmental Research Division, Korea Institute of Construction Technology, 2311, Deawha-dong, Ilsan-gu, Gyeonggi-do, Goyang-si 411-712, Republic of Korea
[d] School of Advanced Materials Science and Engineering, Sungkyunkwan University, Suwon 440-746, South Korea

Separation and Purification Technology 197 (2018) 388–400
Contents lists available at ScienceDirect
Separation and Purification Technology
journal homepage: www.elsevier.com/locate/seppur

Efficiency evaluation of arsenic(III) adsorption of novel graphene oxide@ iron-aluminium oxide composite for the contaminated water purification

Sweta Maji[a], Ayan Ghosh[a], Kaushik Gupta[a], Abir Ghosh[a], Uttam Ghorai[b], Angshuman Santra[b], Palani Sasikumar[a,*], Uday Chand Ghosh[a,b,*]

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[b] Department of Industrial and Applied Chemistry, Ramakrishna Mission Vidyamandira (Autonomous College), Belur Math, Howrah 711202, West Bengal, India

Journal of Hazardous Materials 342 (2018) 260–269
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Journal of Hazardous Materials
journal homepage: www.elsevier.com/locate/jhazmat

Research paper

Sustainable magnet-responsive nanomaterials for the removal of arsenic from contaminated water

Roberto Nisticò[a,b,*], Luisella R. Celi[c], Alessandra Bianco Prevot[a], Luciano Carlos[d], Giuliana Magnacca[a,e], Elena Zanzo[c], Maria Martin[c]

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[b] Polytechnic of Torino, Department of Applied Science and Technology DISAT, C.so Duca Degli Abruzzi 24, 10129 Torino, Italy
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[d] Instituto de Investigación y Desarrollo en Ingeniería de Procesos, Biotecnología y Energías Alternativas, PROBIEN (CONICET-UNCo), Buenos Aires 1400, Neuquén, Argentina
[e] NIS (Nanostructured Interphases and Surfaces) Centre, Via P. Giuria 7, 10125 Torino, Italy

Reviews in Environmental Science and Bio/Technology **3**: 43–53, 2004. 43

Review

Arsenic removal technologies for drinking water treatment

Kuan-Seong Ng[1], Zaini Ujang[1] & Pierre Le-Clech[2,*]
[1]*Institute of Environmental and Water Resource Management, Faculty of Civil Engineering, Universiti Teknologi Malaysia, Malaysia;* [2]*UNESCO Centre for Membrane Science and Technology, School of Chemical Engineering and Industrial Chemistry, University of New South Wales, Sydney 2052, Australia (*author for correspondence, phone: +61-2-93854339; fax: +61-2-93855966; e-mail: p.le-clech@unsw.edu.au)*

Key words: adsorption, arsenic, coagulation, hybrid system, membrane, removal

Why are there so many papers on this topic?

Journal of Hazardous Materials B76 (2000) 125–138
Journal of Hazardous Materials
www.elsevier.nl/locate/jhazmat

The management of arsenic wastes: problems and prospects

M. Leist*, R.J. Casey, D. Caridi
School of Life Sciences and Technology, Victoria University of Technology, Footscray Park Campus (F008), PO Box 14428, MCMC, Victoria 8001, Australia

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Available online at www.sciencedirect.com
ScienceDirect
Desalination 217 (2007) 139–166
DESALINATION
www.elsevier.com/locate/desal

Arsenic toxicity, health hazards and removal techniques from water: an overview

Thomas S.Y. Choong[a], T.G. Chuah[a*], Y. Robiah[a], F.L. Gregory Koay[a], I. Azni[b]
[a]*Department of Chemical and Environmental Engineering,* [b]*Water Technology Centre, Faculty of Engineering, Universiti Putra Malaysia, Serdang 43400, Selangor, Malaysia*
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Received 9 August 2005; Accepted 28 January 2007

DESALINATION
Desalination 103 (1995) 79–88

An overview of arsenic removal processes

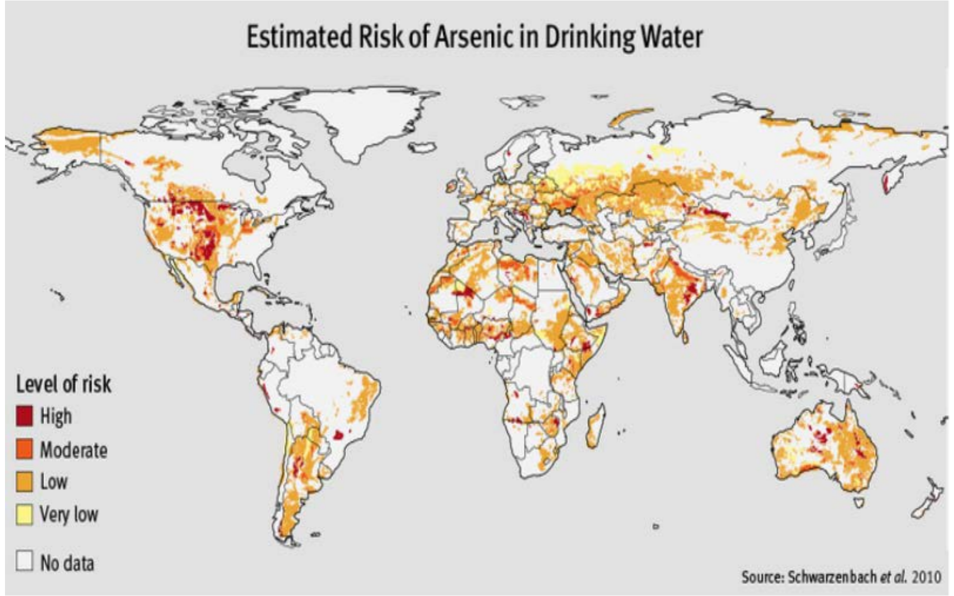
Ernest O. Kartinen*, Jr. and Christopher J. Martin
Boyle Engineering Corporation, 2601 F Street, Bakersfield, CA 93301, USA Tel.: 805-3257253

ACS Sustainable Chemistry & Engineering
Research Article
Cite This: *ACS Sustainable Chem. Eng.* 2019, 7, 9220–9227
pubs.acs.org/journal/ascecg

Lanthanum(III)-Coated Ceramics as a Promising Material in Point-of-Use Water Treatment for Arsenite and Arsenate Removal

Haiyan Yang,[†,‡] Xiaopeng Min,[†] Shangping Xu,[‡] and Yin Wang[*,†]
[†]Department of Civil and Environmental Engineering and [‡]Department of Geosciences, University of Wisconsin—Milwaukee, Milwaukee, Wisconsin 53201, United States

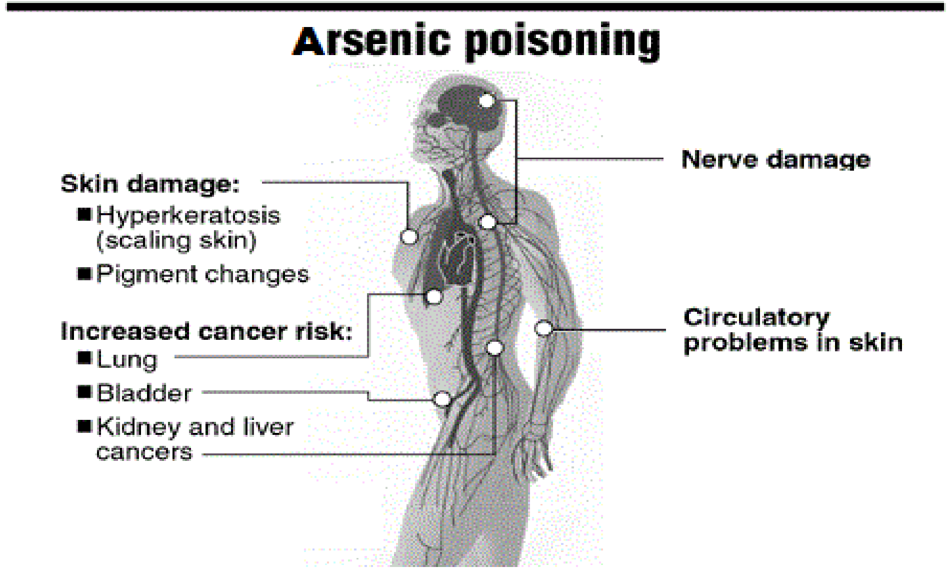
Arsenic contamination of groundwater

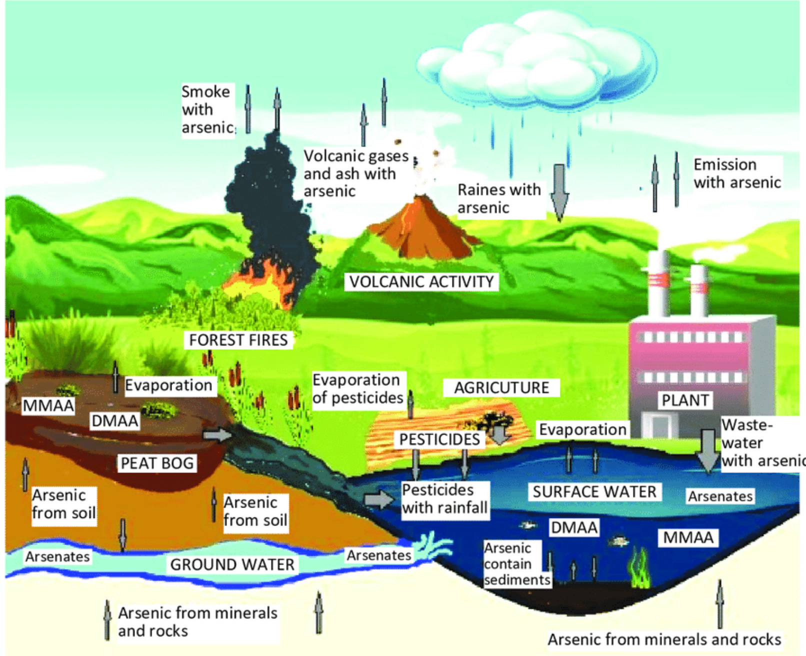


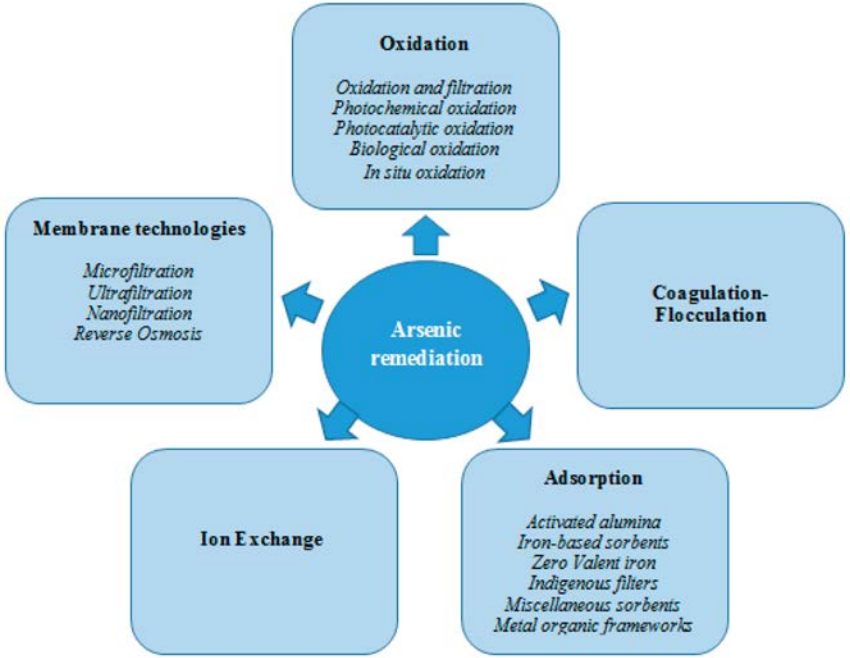
!

The recommended limit of arsenic concentration in drinkining water (according to the WHO guidelines):

0.01 mg/L







Journal of Cleaner Production 278 (2021) 123805

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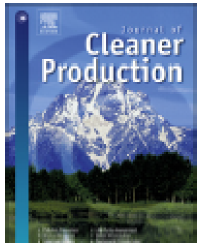
Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



Review

Arsenic removal technologies and future trends: A mini review

Sadiya Alka [a], Shafinaz Shahir [a, **], Norahim Ibrahim [a], Mohammed Jibrin Ndejiko [b], Dai-Viet N. Vo [c], Fazilah Abd Manan [a, *]

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[b] *Department of Microbiology, Faculty of Natural Sciences, Ibrahim Badamasi Babangida University Lapai, Nigeria*
[c] *Center of Excellence for Green Energy and Environmental Nanomaterials (CE@GrEEN), Nguyen Tat Thanh University, 300A Nguyen Tat Thanh, District 4, Ho Chi Minh City, Viet Nam*

And the best method is...

A R T I C L E I N F O

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Keywords:
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Arsenic contamination
Removal techniques
Health hazards
Toxicity
Arsenic occurrence

Arsenic contamination has been widely recognized as one of the most consequential environmental pollutants due to its anthropogenic activities. Arsenic toxicity and remediation have become the focus of many institutions, including industries, environmental groups, and the general public. The treatment of arsenic contamination is of irrefutable significance to lower floras and faunas, humanity, and their living ecosystem. This review comprehensively examines different arsenic toxicities to the environment and their associated removal techniques. To begin with, the appraisal focuses on the general background of arsenic occurrences in the environment, its related health hazards, and measurement techniques. In addition, it also provides a comprehensive discussion of how arsenic impurities can be removed from the environment using diverse established and advanced technologies like adsorption, ion exchanges, electrokinetic processes, electrocoagulation, chemical precipitation, phytoremediation, nano phytoremediation, membrane technology, and phytobial remediation. Finally, the pros and cons of the remediation/removal methods are enumerated, as well as their principal ongoing accomplishments. The simplicity, low cost, and easy operational procedure of adsorption technique and use of novel functional materials such as graphite oxides, metal organic frameworks, carbon nanotubes and other new forms of functional materials are better future alternatives for arsenic removal.

What material should I choose as an adsorbent?

Commercially available material?

Not innovative!

Should I create a completely new material?

A lot of adsorbents have already been synthesized!

Let's take a commercially available adsorbent and modify it with lanthanide ions!

Main targets

Material: Ferrix A33E (Purolite, USA)

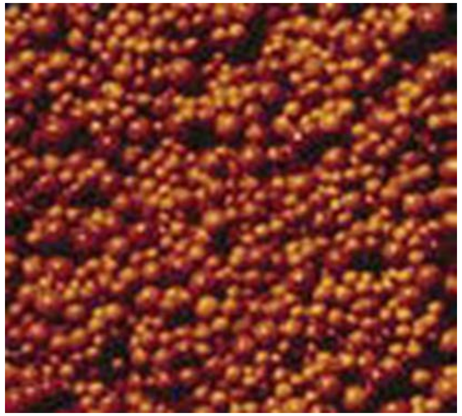
Structure:

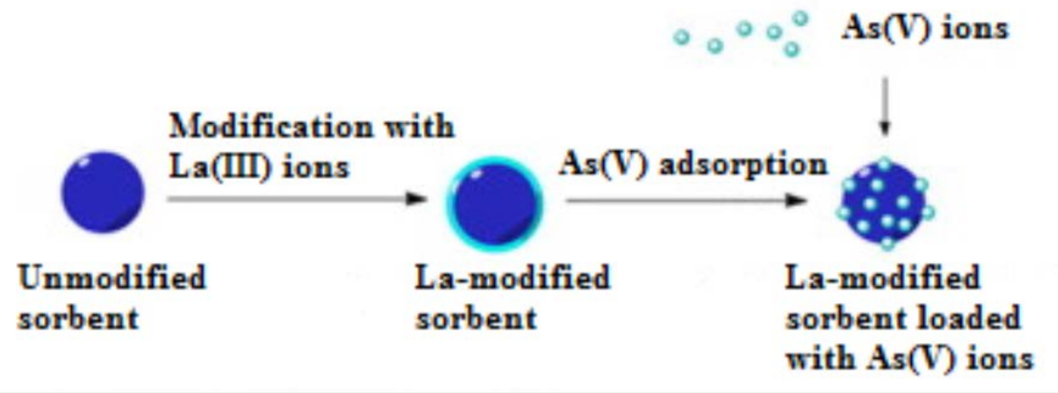
Polystyrene crosslinked with divinylbenzene

Infused with nano-sized particles of iron oxide

Appearance: Brown spherical beads

Functional groups: quaternary ammonium groups





Series of three papers

1

Journal of Molecular Liquids 347 (2022) 117985

Contents lists available at ScienceDirect

Journal of Molecular Liquids

journal homepage: www.elsevier.com/locate/molliq

Arsenic(V) removal on the lanthanum-modified ion exchanger with quaternary ammonium groups based on iron oxide

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lanthanum(III)

2

Journal of Environmental Management 307 (2022) 114551

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Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Arsenate removal on the iron oxide ion exchanger modified with Neodymium(III) ions

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neodymium(III)

cerium(III)

3

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Arsenate removal on the ion exchanger modified with cerium(III) ions

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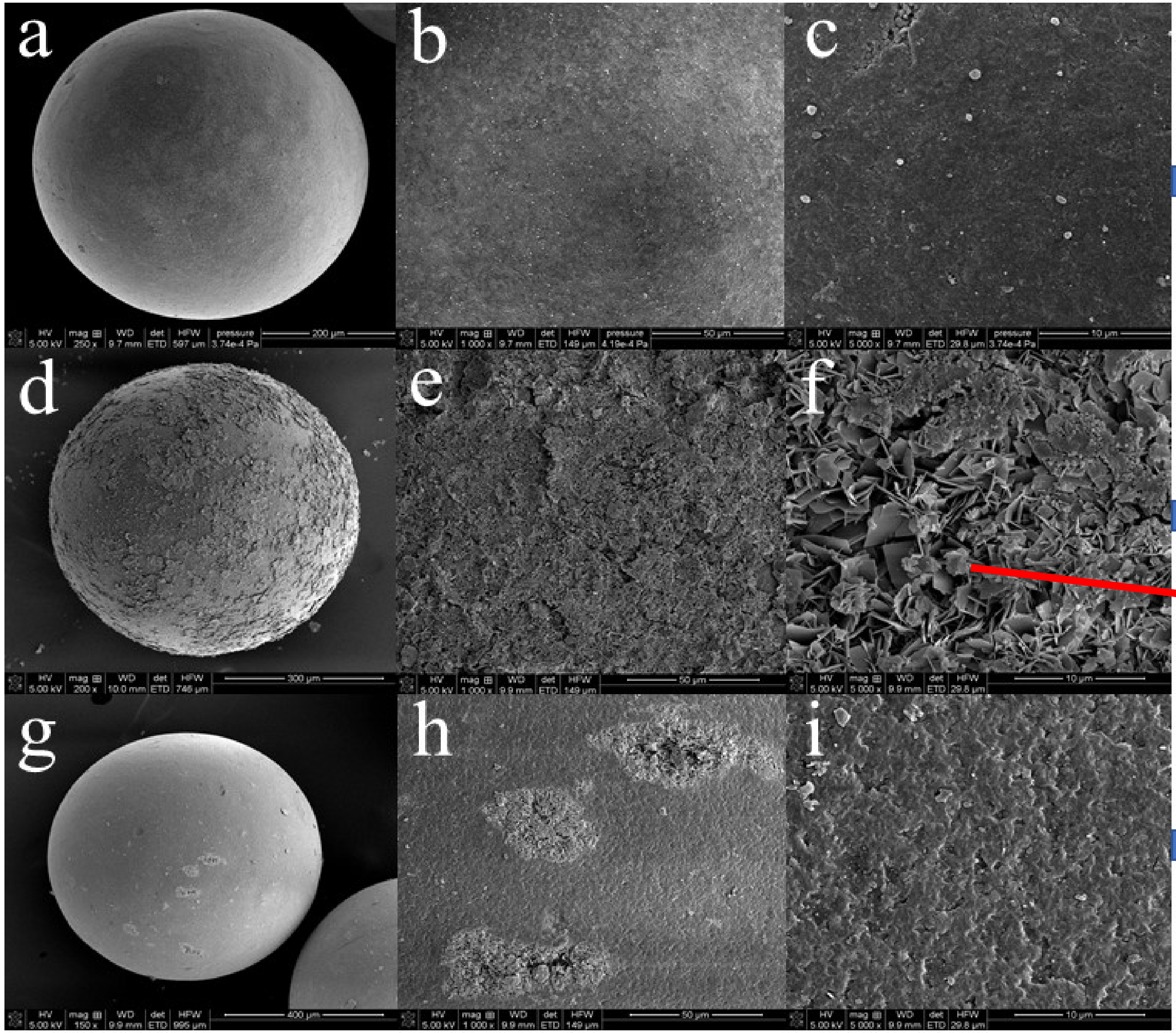
Corresponding author: sebastian.dudek@mail.umcs.pl (Sebastian Dudek)

SEM analysis



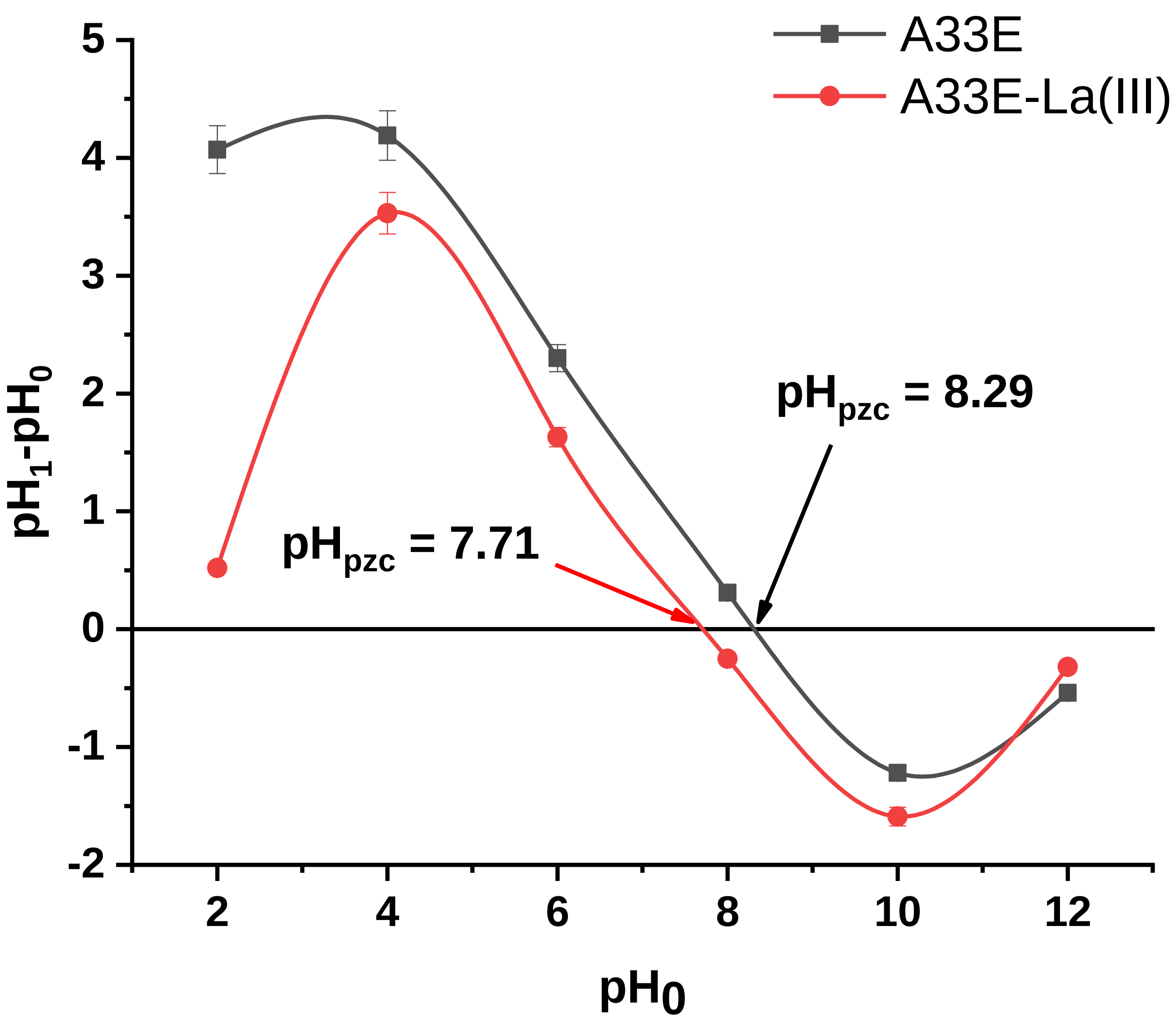
A33E

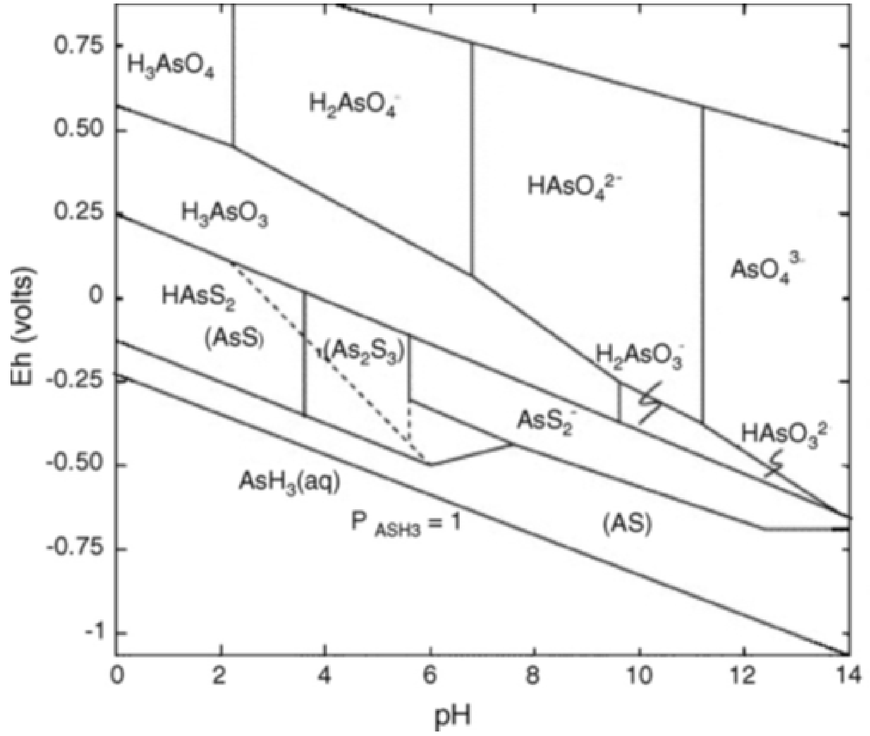
A33E-La(III)

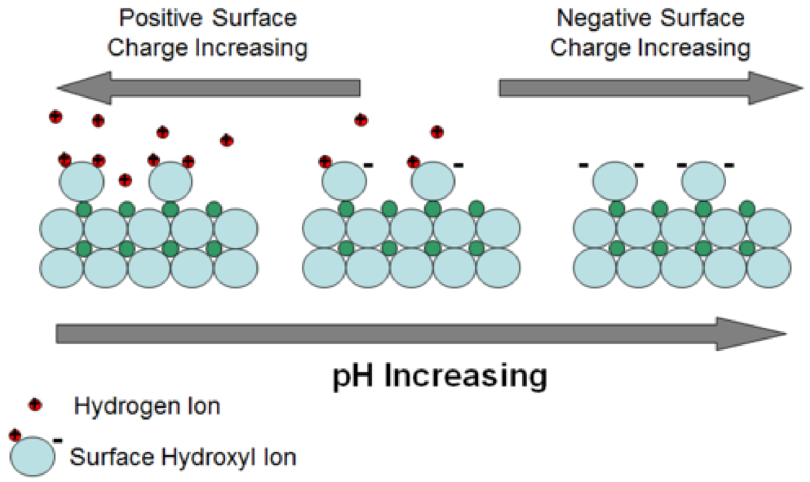
nanoflakes
average diameter 800 nm

A33E-La(III)-As(V)

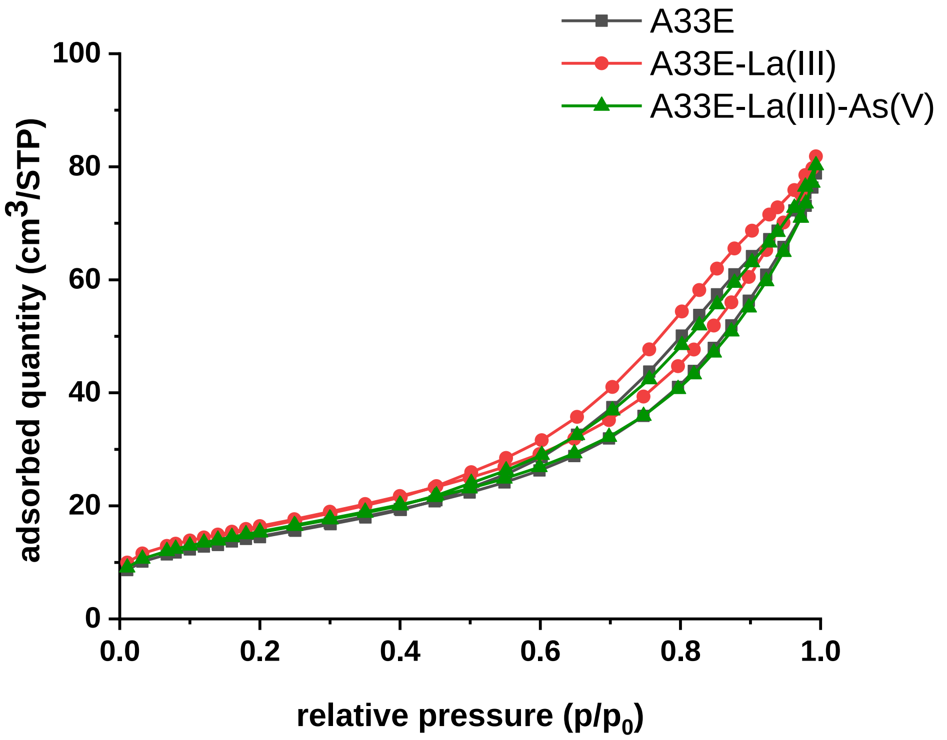
Point of zero charge pH_{PZC}

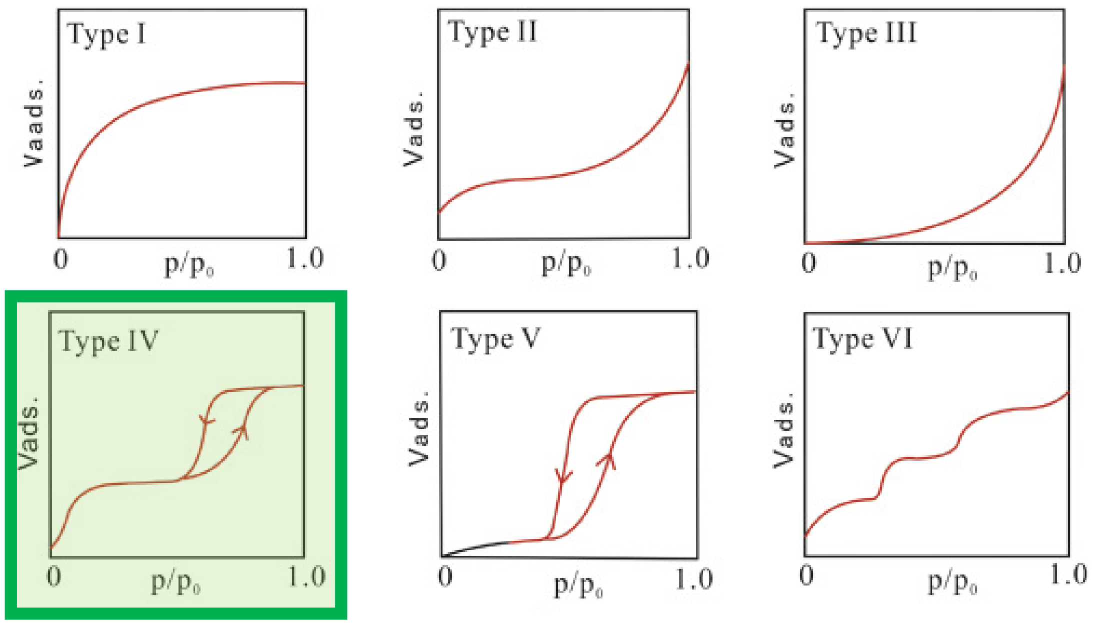


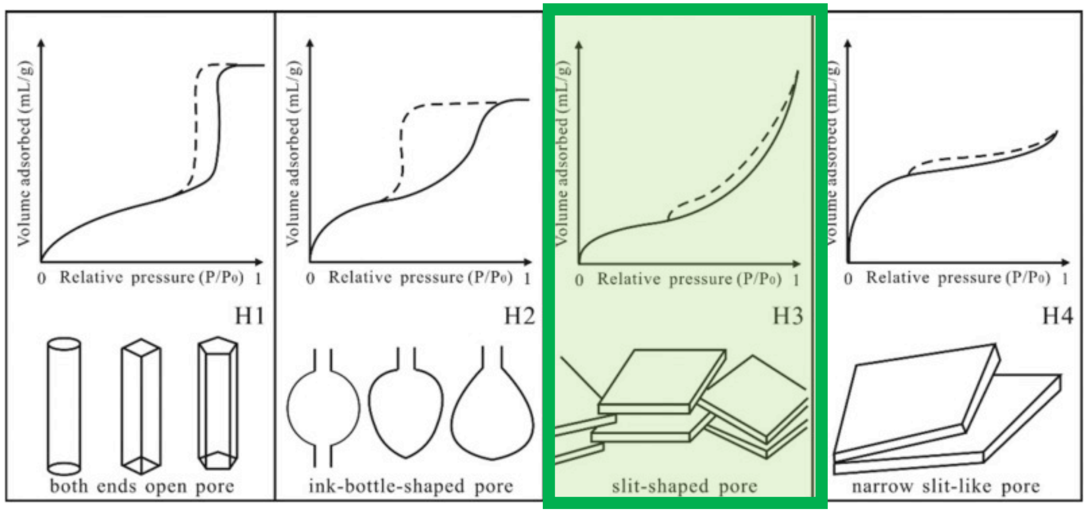




N_2 adsorption/desorption study





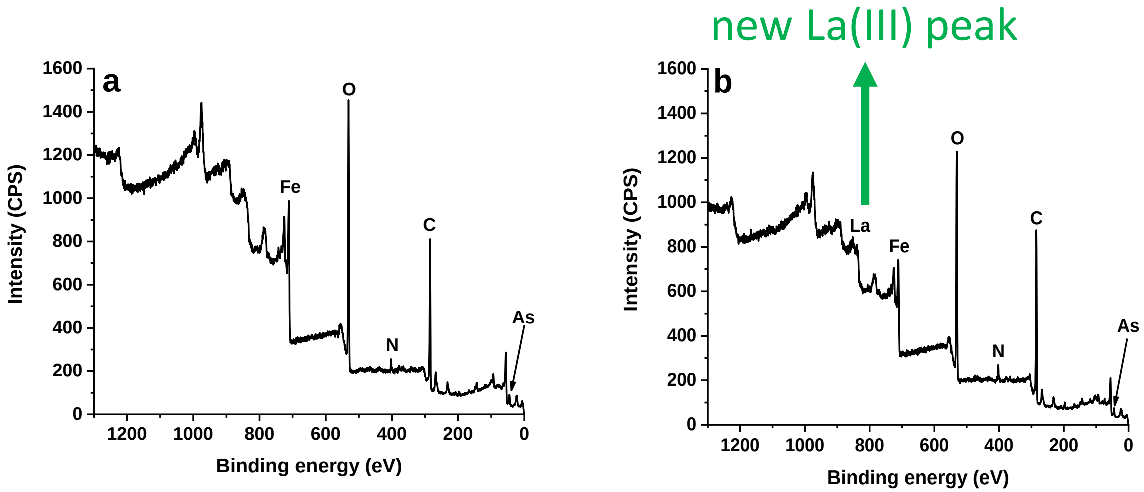


Ion exchanger	A33E	A33E-La(III)	A33E-La(III)-As(V)
Specific surface area (S_{BET}) (m^2/g)	53.12	59.39	56.04
Total pore volume (V_t) (cm^3/g)	0.122	0.127	0.124
Average pore diameter (D_p) (nm)	9.18	8.53	8.86

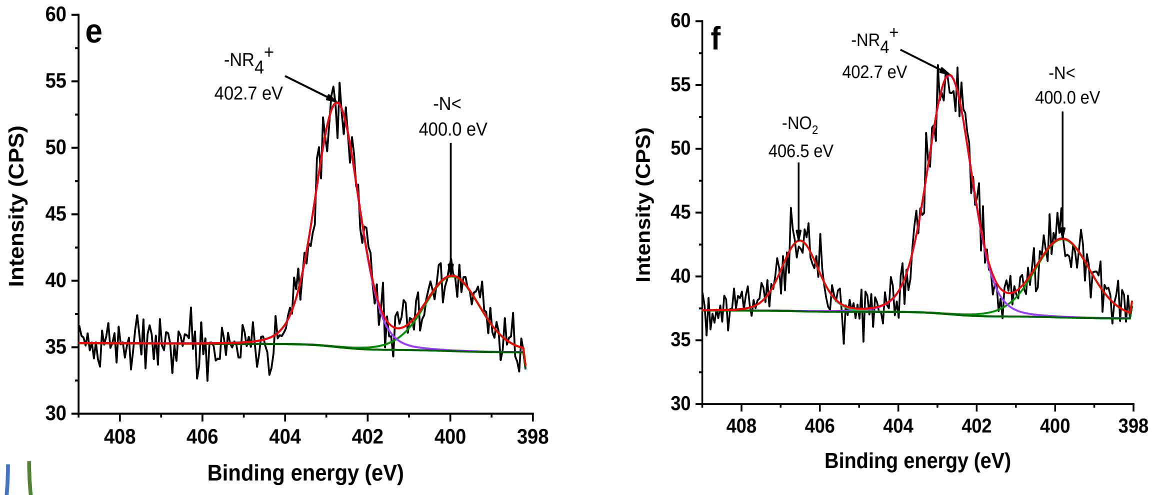
S_{BET} ↑

mesopores

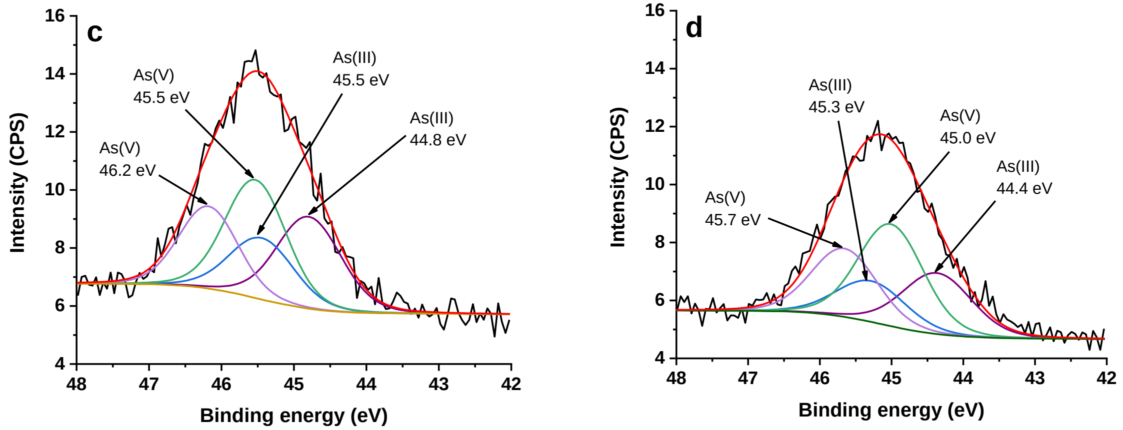
XPS



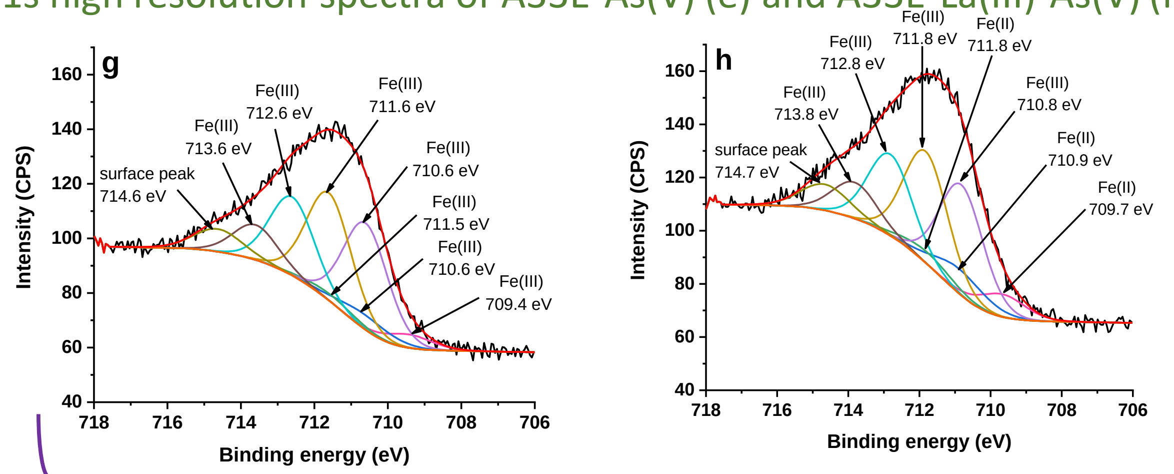
XPS full spectra of A33E-As(V) (a) and A33E-La(III)-As(V) (b)



N1s high resolution spectra of A33E-As(V) (e) and A33E-La(III)-As(V) (f)

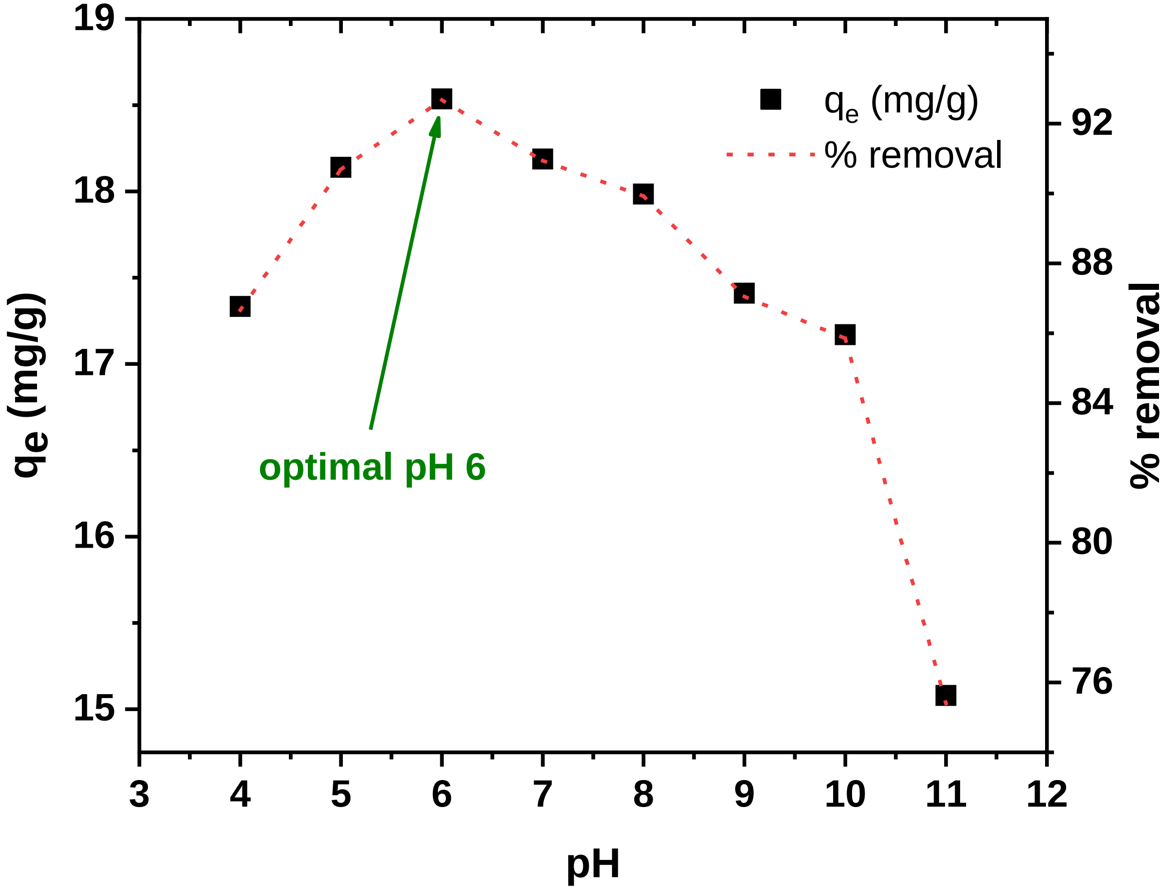


As3d high resolution spectra of A33E-As(V) (c) and A33E-La(III)-As(V) (d)

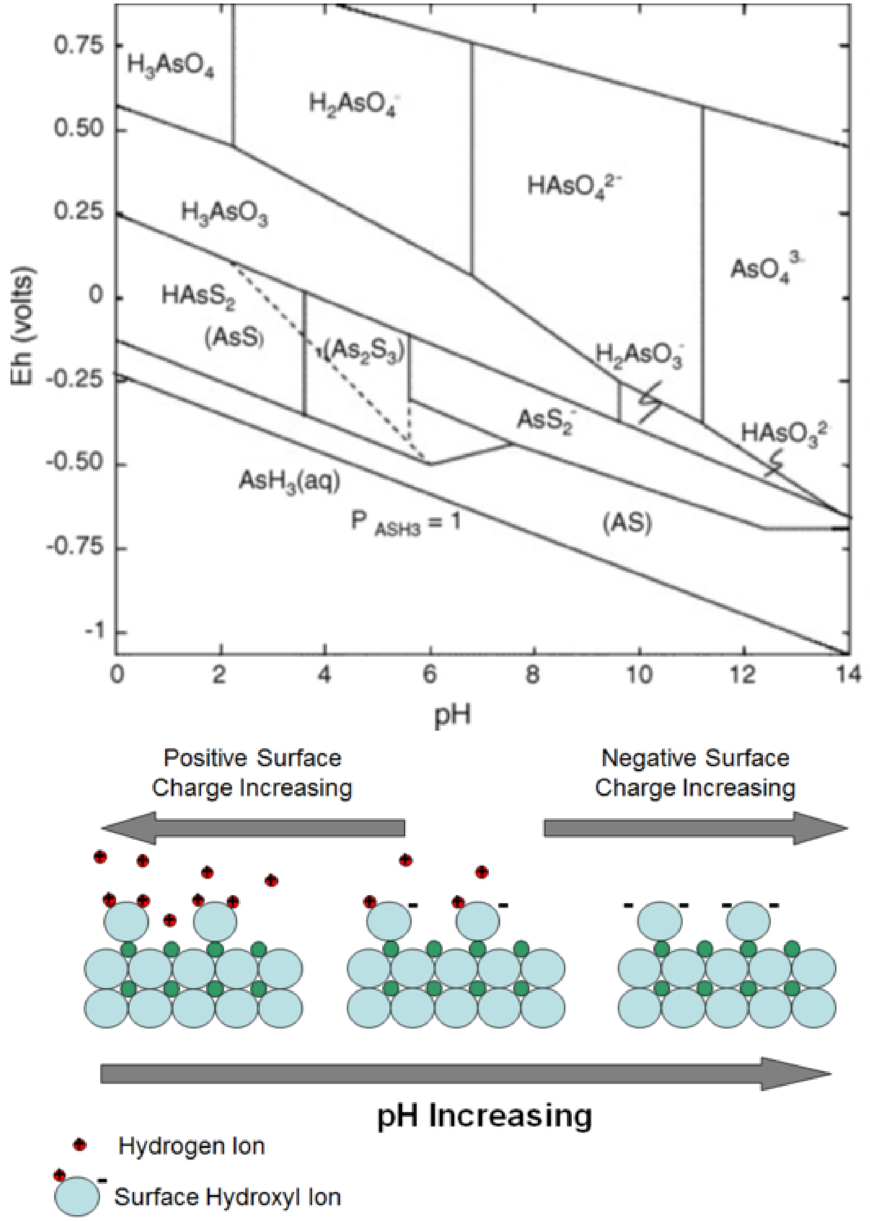


Fe2p high resolution spectra of A33E-As(V) (g) and A33E-La(III)-As(V) (h)

Effect of pH



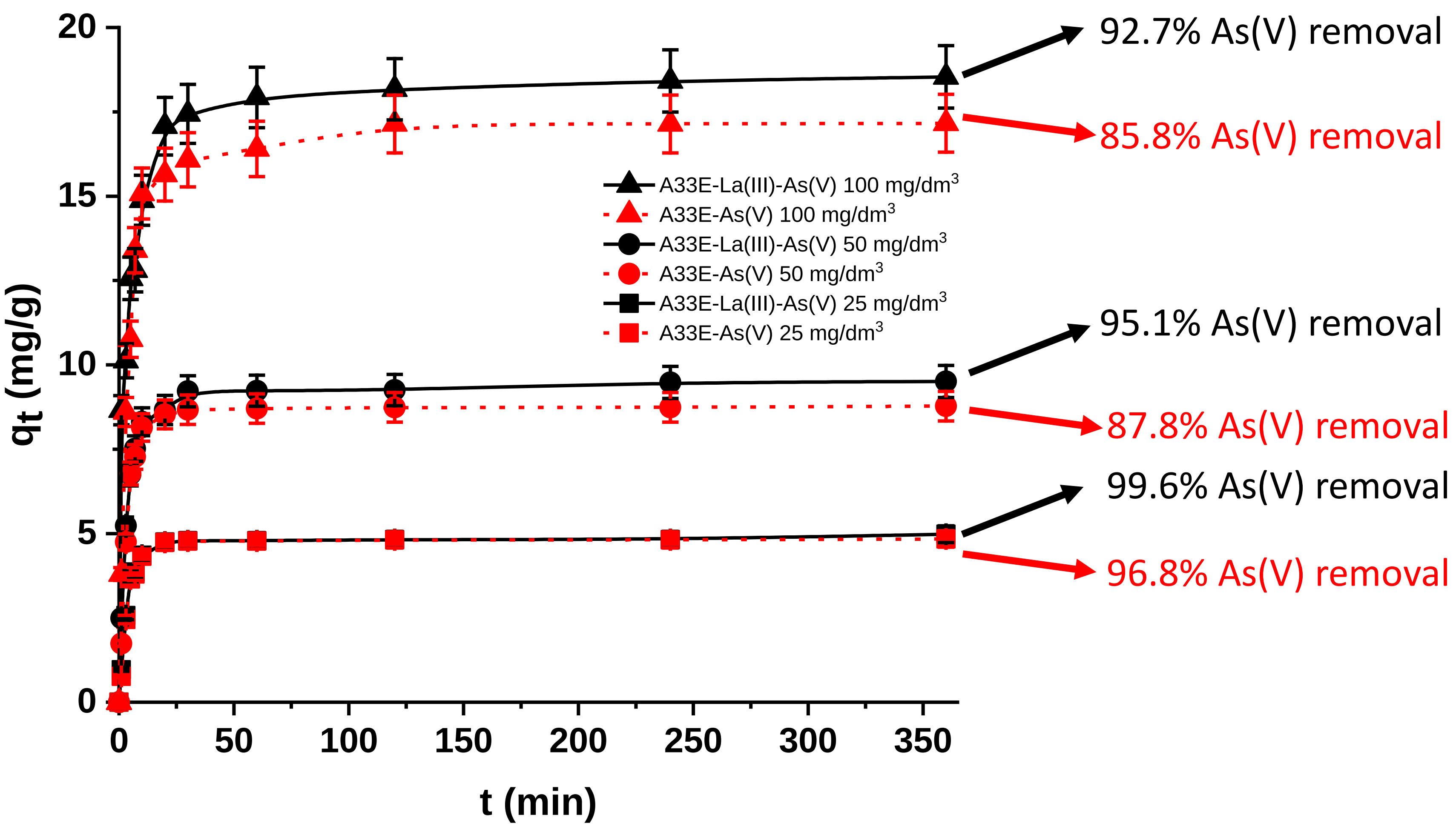
Effect of pH on adsorption of As(V) ions on A33E-La(III) (c_0 = 100 mg/dm^3, pH range 4-11, mass 0.1 g, time 360 min; temperature 295 K, shaking speed 180 rpm).

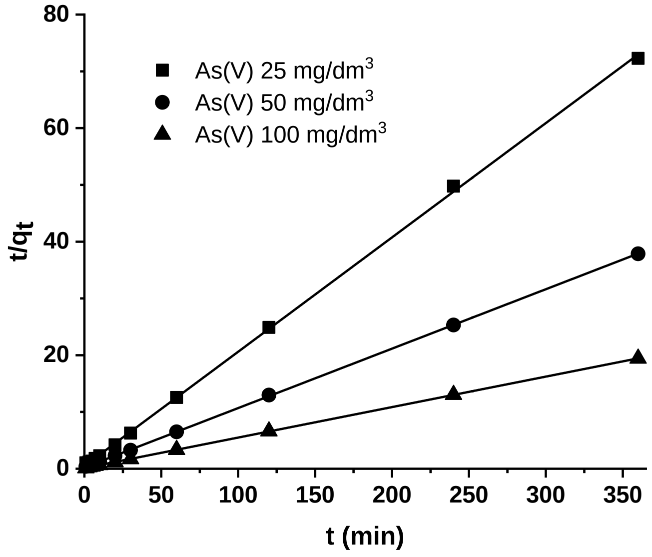


pH 6:

arsenate(V) ions electrostatically attracted to the positively charged surface

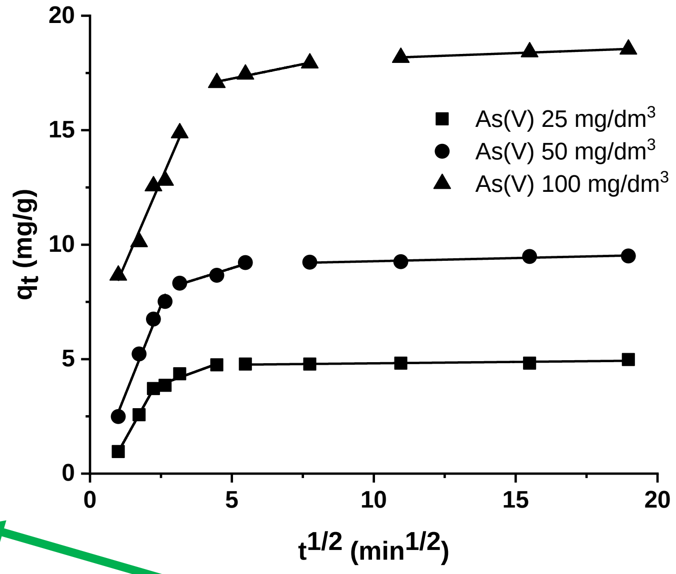
Kinetic studies





PSO

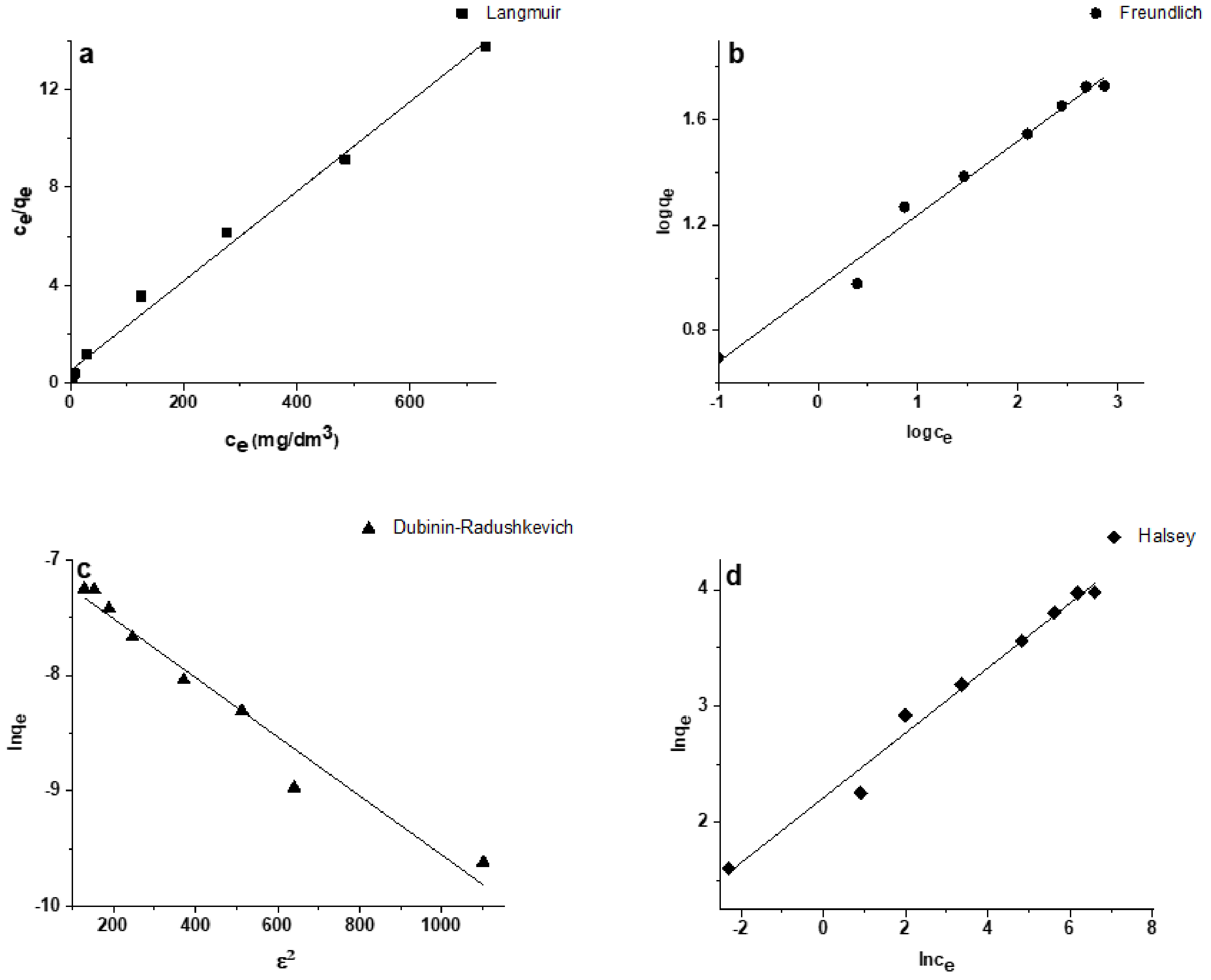
chemisorption



1) fast diffusion of As(V) ions from the bulk fluid phase to the external surface of A33E-La(III)
2) intraparticle diffusion process
3) chemisorption

IPD

Adsorption equilibrium isotherms



Parameters and error analysis	
Langmuir model	
q_m (mg/g)	54.64
K_L (dm^3/mg)	0.035
R_L	0.530
R^2	0.992
SSE	227.68
F-Test	0.69
Freundlich model	
K_F (mg/g)	9.119
n	3.582
R^2	0.985
SSE	34.58
F-Test	0.96
Dubinin-Radushkevich model	
q_{DR} (mol/g)	$9.177 \cdot 10^{-4}$
β (mol^2/J^2)	$2.564 \cdot 10^{-9}$
E (kJ/mol)	13.97
R^2	0.964
SSE	88.40
F-Test	0.73
Halsey model	
n_H	-3.582
K_H	$3.646 \cdot 10^{-4}$
R^2	0.985
SSE	34.58
F-Test	0.96

q_{exp} 53.33 mg/g (modified)
q_{exp} 34.41 mg/g (unmodified)

favourable adsorption

better fit than Langmuir model

chemisorption

good fit multilayer adsorption could not be excluded

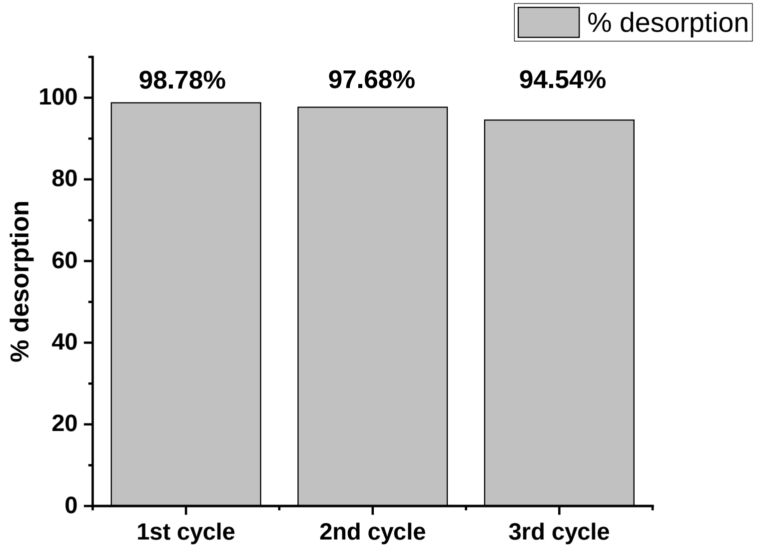
Thermodynamic studies

T (K)	q_e (mg/g)	c_e (mg/g)	K_d (dm^3/g)	ΔG^0 (kJ/mol)	ΔH^0 (kJ/mol	ΔS^0 (kJ/mol·K)
295	53.33	733.33	0.073	-10.51	-12.347	-0.0064
313	40.00	800.00	0.050	-10.18		
333	34.00	830.00	0.041	-10.28		

exothermic

spontaneous

decreased randomness



Reusability of A33E-La(III)

Desorbing agent: 1M NaOH

After 3 cycles sorption-desorption: 18.51 mg/g ➔ 17.40 mg/g

still better than A33E

Conclusions

- ✓ The lanthanum-modified iron oxide adsorbent was successfully obtained by adsorption of lanthanum(III) ions on Ferrix A33E.
- ✓ The maximum sorption capacity towards As(V) ions increased from 34.41 to 53.33 mg/g.
- ✓ A33E-La(III) was characterized by better sorption capacities at the initial As(V) concentration 25, 50 and 100 mg/dm^3.
- ✓ At optimal pH 6 the arsenate(V) ions were adsorbed through the formation of inner-sphere monodentate or bidentate complexes as well as lanthanum arsenate precipitation.
- ✓ Even after 3 cycles of adsorption-desorption, A33E-La(III) had still larger As(V) adsorption than that of A33E.
- ✓ The exceptional As(V) removal capability of lanthanum-modified A33E-La(III) leads to its potential application for not expensive treatment of arsenic-contaminated water.

Thank you for your attention!