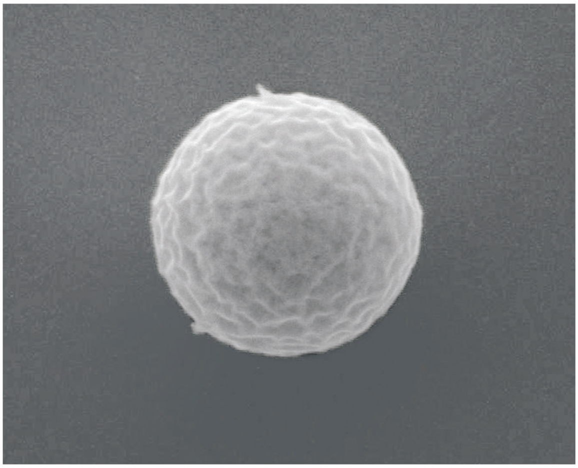

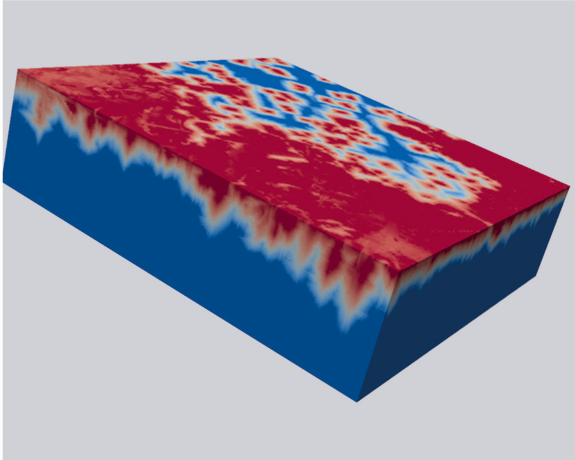

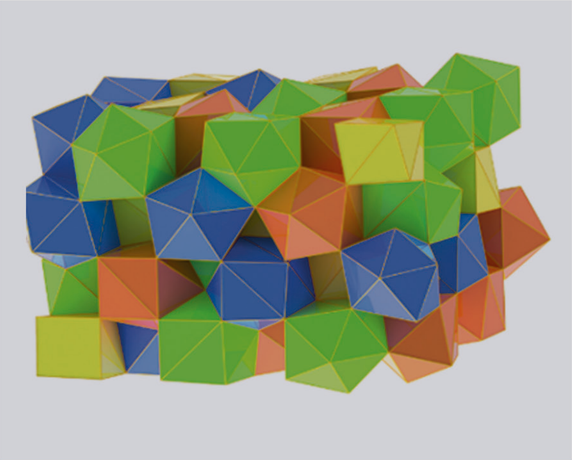

Institute of Energy and Climate Research
IEK-6: Nuclear Waste Management
Report 2015 / 2016

Material Science for Nuclear Waste Management

S. Neumeier, H. Tietze-Jaensch, D. Bosbach (Editors)

Energie & Umwelt / Energy & Environment
Band / Volume 406
ISBN 978-3-95806-293-1

Mitglied der Helmholtz-Gemeinschaft

JÜLICH
Forschungszentrum

Forschungszentrum Jülich GmbH
Institut für Energie- und Klimaforschung
Nukleare Entsorgung und Reaktorsicherheit (IEK-6)

Institute of Energy and Climate Research IEK-6: Nuclear Waste Management Report 2015 / 2016

Material Science for Nuclear Waste Management

S. Neumeier, H. Tietze-Jaensch, D. Bosbach (Editors)

Schriften des Forschungszentrums Jülich
Reihe Energie & Umwelt / Energy & Environment Band / Volume 406

ISSN 1866-1793 ISBN 978-3-95806-293-1

TABLE OF CONTENTS

1 Research for the safe management of nuclear waste 5
2 Institute's profile 7
3 Key research topics 9
  3.1. Safety research for nuclear waste disposal 9
    3.1.1 High-level radioactive waste 10
    3.1.2 Secondary phases 12
    3.1.3 Reactive transport modelling 13
  3.2. Structure research 14
    3.2.1 Solid state chemistry - Helmholtz Young Investigator Group 15
    3.2.2 Atomistic modelling - Juelich Young Investigator Group 16
    3.2.3 Structure analytics 17
  3.3. Waste management concepts for special radioactive wastes 18
    3.3.1 Characterisation of nuclear waste 19
    3.3.2 Nuclear waste treatment 20
    3.3.3 Separation chemistry 21
    3.3.4 Ceramic waste forms 22
  3.4. Nuclear safeguards and security 23
    3.4.1 Concepts, methods and techniques for nuclear safeguards and security applications 24
    3.4.2 Analytical methods for safeguards applications 25
4 Facilities 27
  4.1. Solution calorimeter Setaram C80 27
  4.2. Combined piston cylinder / Multi anvil press 28
  4.3. Microparticle production set-up 29
  4.4. FaNGaS, a new instrument for Fast Neutron Gamma Spectroscopy installed at FRM II in Garching 30
  4.5. Hot-cell facility 31
  4.6. Single-pass flow through experiments 32
  4.7. X-ray diffraction analysis 32
  4.8. Electron microscopy 33
  4.9. Non-destructive assay testing 34
  4.10. Radiochemical analytics 35
  4.11. Miscellaneous 35
5 About IEK-6 37
  5.1. Staff 37

5.2. Organisation chart 38
5.3. Budget 39
6 Scientific and technical reports 2015/2016 41
6.1. Unravelling corrosion mechanisms of spent nuclear fuels in the repository environment 41
6.2. Radionuclide bandwidth calculation in the inventory of PWR-UO_2 spent fuel derived from reactor design and operating data 46
6.3. Radionuclide retention by secondary phases in the repository environment 47
6.4. Retention of radium by solid-solution formation: kinetic and microstructural aspects 54
6.5. Reactive transport modelling: An attractive tool to support safety assessments for nuclear waste disposal 61
6.6. Hydrometallurgical separation of minor actinides 71
6.7. Diglycolamides – complex chemistry in organic and aqueous systems 73
6.8. An advanced TALSPEAK flowsheet test for the selective separation of minor actinides 76
6.9. Selective separation of Am(III) from highly radioactive PUREX raffinate (HGF Milestone 2016) 79
6.10. Radiolysis studies of important solvent extraction systems 83
6.11. Stabilization of defect fluorite phase in UO_2-$NdO_{1.5}$ system 87
6.12. Dissolution behaviour of inert matrix fuel 91
6.13. Pyrochlore and defect fluorite ceramics for nuclear waste immobilization: Structural, thermodynamic and computational insights 95
6.14. Monazite-type ceramic waste forms for the immobilisation of tri- and tetravalent actinides 101
6.15. Structural investigations of amorphous geopolymers using synchrotron radiation and radial distribution functions 106
6.16. Stabilization of pentavalent uranium in oxo-phases 109
6.17. Np^{IV} and Np^{VI} phase formation as a result of complex redox behaviour within aquatic Np-Se oxo-systems 115
6.18. Atomistic modeling in nuclear waste management 120
6.19. Joint atomistic modeling and experimental investigation of ceramic waste materials 126
6.20. Neutron based analytical techniques for radioactive waste assay 132
6.21. Treatment of nuclear graphite for the safe management 138
6.22. Safeguards systems analysis: Further development of quantitative methods 145
6.23. Production of U_3O_8 microparticle reference materials for nuclear safeguards 150

6.24. Non-nuclear applications 157

7 Education and training activities 159

7.1. Courses taught at universities by IEK-6 staff 160

7.2. Appointment 161

7.3. Graduates 162

7.3.1 Bachelor, Diploma, Master thesis 162

7.3.2 Doctoral thesis 162

7.4. Vocational training 163

7.5. Further education and information events 163

7.6. Institute seminar 165

7.6.1 Internal talks 2015 165

7.6.2 Internal talks 2016 167

7.6.3 Invited talks 2015 169

7.6.4 Invited talks 2016 170

7.7. Visiting scientists / Research visits 171

8 Awards 173

8.1. Poster awards 174

8.2. Scholarships 174

9 Selected R&D projects 175

9.1. EU projects 175

9.2. More projects 175

10 Committee work 177

11 Publications 181

11.1. Publications 2015 182

11.1.1 Journal papers 182

11.1.2 Proceedings/Books 185

11.1.3 Reports 187

11.1.4 Poster 188

11.1.5 Presentations 191

11.2. Publications 2016 200

11.2.1 Journal paper 200

11.2.2 Proceedings/Books 203

11.2.3 Reports 204

11.2.4 Poster 204

11.2.5 Presentations 206

12 How to reach us 211

13 List of figures 215

14 List of tables 223

Energie & Umwelt / Energy & Environment
Band / Volume 406
ISBN 978-3-95806-293-1

Mitglied der Helmholtz-Gemeinschaft

JÜLICH
Forschungszentrum