

**KEEMIA- JA MATERJALITEHNOLOOGIA TEADUSKOND
ANORGAANILISTE MATERJALIDE TEADUSLABORATOORIUM
TEADUS- JA ARENDUSTEgevuse AASTAARUANNE 2013**

1. Struktuur

Struktuuriüksuse nimetus eesti ja inglise keeles, direktori /juhataja nimi

Anorgaaniliste materjalide teaduslaboratoorium. Juhataja Rein Kuusik

Laboratory of Inorganic Materials. Laboratory manager Rein Kuusik

2. Teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

2.1 Struktuuriüksusesse kuuluvad uurimisgrupid (*kõik uurimisgrupid näidatakse aruandes eraldi, järgides alltoodud ülesehitust*).

Labor pole jagatud allüksusteks. Küll aga on laboris kaks tihedalt läbipõimunud tegevusega uurimisgruppi: looduslike mineraalide/maavarade ja tööstusheitmete grupp (R. Kuusik) ning apatiitsete materjalide grupp (K.Tõnsuaadu).

Laboratooriumi **tegevusvaldkond** on anorgaaniliste materjalide keemia ja tehnoloogia, kitsamalt alus- ja rakendusuringud anorgaanilistes mitmekomponentsetes süsteemides uute omadustega materjalide väljatöötamiseks, uute kasutusvaldkondade leidmiseks Eesti maavaradele, samuti tööstusheitmete vähendamiseks, taaskasutamiseks ning nende loodushoidlikuks ladustamiseks.

2.1.1 teadustöö kirjeldus (*inglise keeles*);

By clarifying reactions and phase transitions in some heterogeneous natural and technical, mainly Ca and Mg compounds containing carbonatic and phosphatic systems, theoretical fundamentals and applied recommendations are worked out to find new solutions for exploitation of Estonian natural resources, for obtaining new catalysts and fertilizers with improved properties, for utilizing industrial solid wastes and/or for their environmentally friendly storage. The project covers research in three closely related workpackages: 1. Carbonatic/sulphatic systems; wastes of oil shale energetics, abatement of CO₂ emissions, PCC; 2. Phosphatic/carbonatic systems; substituted apatites, new sorbents and catalysts; 3. Carbonatic/nitric systems; new usage areas for mineral resources, clinker dust, fertilizers with improved properties.

2.1.2 aruandeaastal saadud tähtsamad teadustulemused (*inglise keeles*).

- The studies of indirect aqueous carbonation of oil shale ash with PCC production were taken to the next level by using a continuous-flow disintegrator-type reactor and simulation of the process. The process was carried out in two stages: aqueous extraction of Ca-compounds in a stirred-tank reactor, followed by carbonation in a disintegrator-type reactor under various operation conditions. The main characteristics of the resulting crystalline products were established. Starting with basic model

systems and focusing on key Ca-compounds ($\text{Ca}(\text{OH})_2$, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, also hazardous CaS) the ash leaching process was simulated by the means of reactor models built upon reaction kinetics and thermodynamic equilibrium. A 2-step reaction model describing $\text{Ca}(\text{OH})_2$ solubility in water was developed and the kinetic parameters were estimated based on the proposed system of differential equations and experimental data.

- The research in oxy-fuel combustion of oil shale in comparison with conventional combustion conditions and some other common solid fuels (coal, anthracite) was extended. By means of thermal analysis, FTIR, X-Ray and other methods, various characteristics of the process were determined and clarified together with gas-phase analysis, kinetic calculations and thermodynamic modelling. The results of the first experimental cycle allow to conclude that combustion of Estonian oil shale under oxy-fuel conditions is a realistic way for further CO_2 capture-ready operation of boilers while there are no fundamental difficulties in applying the oxy-fuel combustion mode to Estonian OS.
- Experiments for clarifying the possibilities for obtaining granulated oil shale ash products suitable for use in liming of acidic soils are carried out. The results obtained indicated that varying the composition of ash as well as liquid binders and drying regime enables to obtain granules resistant to compressive strength up to 8-12 N. The granules obtained had at that good solubility characteristics in aqueous media.
- For getting the fundamentals for new ceramics, the complex character of transformations and differences in the thermal behaviour of green clay samples from Kunda and Arumetsa deposits and their mixtures with oil shale ashes depending on the chemical and mineralogical composition of the initial materials were established by using TG-DTA-MS and XRD techniques, and in cooperation with Constantine the Philosopher University (Nitra, Slovakia).
- Complex thermodynamic and thermal analysis of systems containing ammonium nitrate (AN)/urea – lime-containing materials were carried out. Possible reactions in these systems and changes in thermal stability of AN/urea were clarified. Possibilities and prospects for modification of AN/urea by coating the seed granules with limestone or dolomite powder using fattening technology were shown.
- The sorption of phospho-amino acids with apatite, wet synthesis of bio-cations (Na, Zn, Mg, Sr) substituted apatites and the catalytic properties of the obtained materials in Biginelli and Glaser-Hay reactions were studied. It was shown that introduction of bio-cations into apatite structure changes the size and shape of crystals and with this also the specific surface area in correlation with the ionic radii of the cation. The surface properties of apatite change in the reaction with P-serine aqua solution but it does not change the catalytic activity of apatite. Apatite catalytic effect also does not increase as a result of binding Cu, Zn, and Pd ions on apatite when used as catalyst in Biginelli reactions. In the Glaser-Hay reactions under heterogeneous conditions using a Cu-modified hydroxyapatite as catalysts yields of 40-99 % were obtained without using auxiliary chelating molecules and organic bases unlike homogeneous catalysts.

- Co-authorship of M.Veidema in a study of international expert group "Strategy and Capacity Building for Fossil Fuel Fired Power Plant in the Maghreb Countries", Final report has passed and approved by World Bank.

2.1.3 Uurimisgrupi kuni 5 olulisemat publikatsiooni aruandeaastal.

1. Velts, O.; Uibu, M.; Kallas, J.; Kuusik, R. (2013). CO₂ mineralisation: Concept for co-utilization of oil shale energetics waste streams in CaCO₃ production. Energy Procedia, 37, 5921 - 5928.
2. Viipsi, K.; Sjöberg, S.; Tõnsuaadu, K.; Shchukarev, A. (2013). Hydroxy- and fluorapatite as sorbents in Cd(II)–Zn(II) multi-component solutions in the absence/presence of EDTA. Journal of Hazardous Materials, 252-253, 91 - 98.
3. Meriste, T.; Yörük, C. R.; Trikkel, A.; Kaljuvee, T.; Kuusik, R. (2013). TG–FTIR analysis of oxidation kinetics of some solid fuels under oxy-fuel conditions. Journal of Thermal Analysis and Calorimetry, 114(2), 483 - 489.
4. Tamm, K.; Kuusik, R.; Uibu, M.; Kallas, J. (2013). Transformations of sulfides during aqueous carbonation of oil shale ash. Energy Procedia, 37, 5905 - 5912.

2.2 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustest.

2.3 Loetelu struktuuriüksuse töötajatest, kes on välisakadeemiate või muude oluliste T&A-ga seotud välisorganisatsioonide liikmed.

Veiderma Mihkel, em.prof., v.teadur – Soome Tehnikateaduste Akadeemia liige
 – New Yorgi Teaduste Akadeemia liige
 – Soome Keemia Seltsi kirjavahetajaliige

Kallas Juha, v.teadur – International Ozone Assosiation, programmkomitee liige
 – European-African-Australian Group, programmkomitee liige

Kuusik Rein, juhtivteadur – rahvusvaheliste konverentside teaduskomitee liige, sektsioonide juhatamine, moderaator

- International Oil Shale Symposium, 10.06.–13.06.2013 Tallinn;
- Leuven, Belgia;–ACEME13, 08.04.–13.04.2013. Leuven, Belgia.
- Jõhvi, Eesti; 14.11.2013 - Põlevkivi tulevik – innovatsioon ;
- Open Petroleum Engineering Journal, toimetuskolleegiumi liige

Kaia Tõnsuaadu , vanemteadur- The 2th Central and Eastern European Conference on Thermal Analysis and Calorimetry, Vilnius, Leedu, orgkomitee liige.

Tiit Kaljuvee, vanemteadur- The 2th Central and Eastern European Conference on Thermal Analysis and Calorimetry, Vilnius, Leedu, orgkomitee liige.

2.4 Soovi korral esitatakse aruandeaastal saadud **T&A-ga seotud tunnustused** (va punktis 2.3 toodud tunnustused), ülevaade teaduskorralduslikust tegevusest, **teadlasmobiilsusest ning hinnang oma teadustulemustele.**

Teadlasmobiilsus 2013

Nimi-Ametikoht-Eesmärk-Ülikool/ organisatsioon-Riik-Aeg-Konverentsi/seminari/näituse/messi nimetus

Rein Kuusik-juhtivteadur

- konverentsil osalemine – Leuven, Belgia; 08.04.–13.04.2013 –ACEME13;
- konverentsil osalemine– Tallinn, Eesti; 10.06.–13.06.2013–International Oil Shale Symposium;
- konverentsil osalemine – Tallinn, Eesti; 11.10.2013 - Keemiapäevade teaduskonverents;
- konverentsil osalemine – Jõhvi, Eesti; 14.11.2013 - Põlevkivi tulevik – innovatsioon ;

Kaia Tõnsuaadu-vanemteadur

- konverentsil osalemine – Vilnius, Leedu; 26.08-31.08.2013 –CEEC-TAC2, A1R;
- konverentsil osalemine –Rennes, Prantsusmaa; 27.10-31.10.2013 –2nd International Symposium on Inorganic and Environmental Materials;

Tiit Kaljuvee-vanemteadur

- konverentsil osalemine– Tallinn, Eesti; 10.06.–13.06.2013–International Oil Shale Symposium;
- konverentsil osalemine – Sheffield, Suurbritannia; 25.06.–03.07.2013 – 6th International Granulation Workshop;
- konverentsil osalemine – Vilnius, Leedu; 26.08-31.08.2013 –CEEC-TAC2, A1R;
- teaduslik lähetus – Hardheim, Saksamaa; 20.10.–23.10.2013 –Maschinenfabric Gustav Eirich&Co KG

Juha Kallas-vanemteadur

- teaduslik lähetus–Lappeenranta, Soome; 07.11.–09.11.2013

Andres Triikkel - vanemteadur

- konverentsil osalemine– Tallinn, Eesti; 10.06.–13.06.2013–International Oil Shale Symposiu
- konverentsil osalemine–Ponferrada, Hispaania; 09.09.–13.09.2013–The 3th OCC

Mai Uibu-vanemteadur

- konverentsil osalemine– Leuven, Belgia; 08.04.–13.04.2013 –ACEME13;
- konverentsil osalemine– Tallinn, Eesti; 10.06.–13.06.2013–International Oil Shale Symposium;
- konverentsil osalemine – Tallinn, Eesti; 11.10.2013 - Keemiapäevade teaduskonverents;
- konverentsil osalemine – Jõhvi, Eesti; 14.11.2013 - Põlevkivi tulevik – innovatsioon ;

Irma Bogdanoviciene-vanemteadur

- konverentsil osalemine –Rennes, Prantsusmaa; 27.10-31.10.2013 –2nd International Symposium on Inorganic and Environmental Materials

Olga Velts- teadur

- konverentsil osalemine– Leuven, Belgia; 08.04.–13.04.2013 –ACEME13;
- teaduslik lähetus –Lappeenranta, Soome; 19.05.–15.06.2013;
- konverentsil osalemine–Alexandria (VA), USA; 23.06.–27.06.2013–12th International Conference on Carbon Dioxide Utilization, ICCDU XII;

Kadriann Tamm- , insener, doktorant

-konverentsil osalemine– Leuven, Belgia; 08.04.–13.04.2013 –ACEME13

-konverentsil osalemine – Tallinn, Eesti; 11.10.2013 - Keemiapäevade teaduskonverents;

-konverentsil osalemine – Jõhvi, Eesti; 14.11.2013 - Põlevkivi tulevik – innovatsioon ;

-doktorikooli konverents –Tallinn, Eesti; 07.03.–08.03.2013–FMTDK

Irina Klimova – insener, doktorant

-konverentsil osalemine – Sheffield, Suurbritannia; 25.06.–03.07.2013 – 6th International Granulation Workshop;

Juhendatud ja kaitstud magistritööd

Herki Hälvin–Granuleeritud komposiitmaterjalid põlevkivituhast ning nende võimalik kasutamine lubiväetistena. Juhendaja vanemteadur Tiit Kaljuvee. Kaitstud 2013

Diana Ravjako–Happeliste gaaside emissiooni vähendamise võimalused ning selle mõju keskkonnale Viru Keemia Grupp AS näitel. Juhendaja teadur Mai Uibu ja kaasjuhendaja juhtivteadur Rein Kuusik. Kaitstud 2013

Juhendatud ja kaitstud bakalaureusetööd

Märten Lukk–Eesti põlevkivi hapnikus- põletamine. Termiline analüüs. Juhendaja vanemteadur Andres Trikkel. Kaitstud 2013

Priit Kallaste– Tasakaalud süsteemis põlevkivituhk – vesi. Juhendaja insener/doktorant Kadriann Tamm. Kaitstud 2013

Hans Priks– Tiosulfaat - ioon põlevkivituha leostamisel ja märgkarboniseerimisel. Juhendaja insener/doktorant Kadriann Tamm. Kaitstud 2013

2.5 Aruandeaasta tähtsamad T&A finantseerimise allikad.

- Sihtfinteema SF0140082s08

2.7 Labori teadus- ja arendustegevuse teemade ja projektide nimetused (*Eesti Teadusinfosüsteemi, edaspidi ETIS, andmetel*)

- Haridus- ja Teadusministeerium

– sihtfinantseeritavad teemad:

SF0140082s08, Karbonaat- ja fosfaatpõhiste anorgaaniliste süsteemide keemia ja rakendused, Kuusik Rein (2008 – 2013)

- SA Eesti Teadusfond/Eesti Teadusagentuur

– grandid:

ETF8207, Katalüsaatorid hüdroksüülapatiidil baseeruvatest hübriidmaterjalidest, Tõnsuaadu Kaia (2010 – 2013)

ETF9334, Happeliste gaaside emissioonide vähendamine ning PCC-tüüpi täitematerjali saamine põlevkivi põletusjäätmete baasil, Uibu Mai (2012 – 2015)

– järel doktorite grandid (SA ETF ja Mobilitas):

MJD285, Merit Nigol (Kindsigo), Põlevkivituha taaskasutus: pidevprotsesside arendus happeliste gaaside emissiooni vähendamiseks ja sadestatud kaltsiumkarbonaadi saamiseks (1.03.2012 - 28.02.2015)

GJE131, Irma Bogdanoviciene, Sorption of bio-molecules on synthetic Ca hydroxyapatites doped with metal ions (ERMOS 15.10.2012-14.10.2015)

- SA Archimedesega sõlmitud lepingud

– riiklikud programmid:

Energiatehnoloogia I, 3.2.0501.10-0002, Põlevkivi põletamisega kaasnevate tahkjäätmete uute kasutusala alused (Tuhk), Rein Kuusik. Labor on koordinaator.

Keskonnatehnoloogia, 3.2.0801.11-0025, Fosforiärrastustehnoloogiad märgalapuhastites: põlevkivituhasette filtersüsteemide omadused ja pikaajaline toimimine (Fosfor), Kalle Kirsimäe. Labor on partner, Kaia Tõnsuaadu.

Energiatehnoloogia II, 3.2.0501.11-0023, Põlevkivi maksimaalse vääristamise alused, Hans Luik. Labor on partner, Mai Uibu.

- Siseriiklikud lepingud:

Lep12115, Põlevkivi termooksüdatsioon - hapnikus-põletamise alusnähtused, Triikkel Andres, Kuusik Rein (1.08.2012 - 30.06.2014)

Lep12116, Granuleeritud põlevkivituhk lubiväetisena - saamine ja iseloomustamine, Kaljuvee Tiit, Kuusik Rein (1.08.2012 - 30.04.2014)

- Välisriiklikud lepingud:

VA433, Hetrogeensete metallkatalüsaatorite loomine apatiidi pinnal, Tõnsuaadu Kaia (1.07.2009 - 30.06.2014)

2.8 Struktuuriüksuse töötajate poolt avaldatud eelretsenseeritavad teaduspublikatsioonid (*ETIS klassifikaatori alusel 1.1, 1.2, 1.3, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1 ja 5.1*).

1.1 Teadusartiklid, mis on kajastatud Web of Science andmebaasis...

1. Uibu, M.; Kuusik, R. (2013). Carbon capture and fixation using lime-containing wastes: the influence of aqueous phase composition on Ca dissolution from oil shale ash. *Energy Procedia*, 37, 5913 - 5920.
2. Velts, O.; Uibu, M.; Kallas, J.; Kuusik, R. (2013). CO₂ mineralisation: Concept for co-utilization of oil shale energetics waste streams in CaCO₃ production. *Energy Procedia*, 37, 5921 - 5928.
3. Raado, L.; Hain, T.; Liisma, E.; Kuusik, R. (2013). Composition and Properties of Oil Shale Ash Concrete . *Oil Shale*, xx - xx. [ilmumas]
4. Viipsi, K.; Sjöberg, S.; Tõnsuaadu, K.; Shchukarev, A. (2013). Hydroxy- and fluorapatite as sorbents in Cd(II)–Zn(II) multi-component solutions in the absence/presence of EDTA. *Journal of Hazardous Materials*, 252-253, 91 - 98.
5. Alanne, A.-L.; Tuikka, M.; Tõnsuaadu, K.; Ylisirniö, M.; Hämäläinen, L.; Turhanen, P.; Vepsäläinen, J.; Peräniemi, S. (2013). Novel bisphosphonate-based solid phase method for effective removal of chromium(III) from aqueous solutions and tannery effluents . *RSC Advances*, 3, 14132 - 14138.
6. Preis, S.; Panorel, I.; Kornev, I.; Hatakka, H.; Kallas, J. (2013). Pulsed corona discharge: the role of ozone and hydroxyl radical in aqueous pollutants oxidation. *Water science & technology*, 68(7), 1536 - 1542.

7. Meriste, T.; Yörük, C. R.; Trikkel, A.; Kaljuvee, T.; Kuusik, R. (2013). TG–FTIR analysis of oxidation kinetics of some solid fuels under oxy-fuel conditions. *Journal of Thermal Analysis and Calorimetry*, 114(2), 483 - 489.
8. Kaljuvee, T.; Keelman, M.; Trikkel, A.; Petkova, V. (2013). TG-FTIR-/MS analysis of thermal and kinetic characteristics of some coal samples. *Journal of Thermal Analysis and Calorimetry*, 113(3), 1063 – 1071.
9. Petkova, V.; Serafimova, E.; Kaljuvee, T.; Pelovsky, Y. (2013). Thermochemical characterization of chicken litter and peat as a source for energy recovery. *Journal of Thermal Analysis and Calorimetry*, 113(2), 683 - 692.
10. Oja Acik, I.; Otto, K.; Krunks, M.; Tõnsuaadu, K.; Mere, A. (2013). Thermal behaviour of precursors for CuInS₂ thin films deposited by spray pyrolysis. *Journal of Thermal Analysis and Calorimetry*, 113(3), 1455 - 1465.
11. Tamm, K.; Kuusik, R.; Uibu, M.; Kallas, J. (2013). Transformations of sulfides during aqueous carbonation of oil shale ash. *Energy Procedia*, 37, 5905 - 5912.

3.1 Artiklid/peatükid lisas loetletud kirjastuste välja antud kogumikes

1. Beganskiene, A.; Stankeviciute, Z.; Malakauskaite, M.; Bogdanoviciene, I.; Mikli, V.; Tõnsuaadu, K.; Kareiva, A. (2013). SOL-GEL APPROACH TO THE CALCIUM PHOSPHATE NANOCOMPOSITES. In: *Nanostructured Materials and Nanotechnology VII: The 37th International Conference on Advanced Ceramics and Composites*, Florida, USA, January 27 - February 1, 2013. (Toim.) S. Mathur, F. Hernandez-Ramirez, S. Kirihara and S. Widjaja. John Wiley & Sons Ltd, 2013, (Ceramic Engineering and Science Proceedings ; Volume 34, Issue 7), 1 - 11.

3.2 Artiklid/peatükid lisas mitte loetletud kirjastuste välja antud kogumikes

1. Tamm, K.; Kuusik, R.; Uibu, M.; Kallas, J. (2013). Behaviour of sulfur compounds during aqueous leaching of oil shale ash. *Proceedings of the 4th International Conference on Accelerated Carbonation for Environmental and Materials Engineering ACEME 2013*, Leuven Belgium, 9-12 April 2013. (Toim.) Nasser, R.; Santos, R.; Cizer, Ö.; Van Gerven, T.. Leuven:, 2013, 541 - 544.
2. Velts, O.; Uibu, M.; Kallas, J.; Kuusik, R. (2013). Efforts in oil shale ash indirect carbonation accompanied by PCC-type material formation. *Proceedings of the 4th International Conference on Accelerated Carbonation for Environmental and Materials Engineering ACEME 2013*, Leuven, Belgium, 9-12 April 2013. (Toim.) Nasser, R.; Santos, R.; Cizer, Ö.; Van Gerven, T.. Leuven:, 2013, 341 - 348.
3. Uibu, M.; Kuusik, R. (2013). Physicochemical factors affecting aqueous carbonation of oil shale ash. *Proceedings of the 4th International Conference on Accelerated Carbonation for Environmental and Materials Engineering ACEME 2013*, Leuven Belgium, 9-12 April 2013. (Toim.) Nasser, R.; Santos, R.; Cizer, Ö.; Van Gerven, T.. Leuven:, 2013, 295 - 304.

3.4 Artiklid/ettekandes 3.1 mittekuuluvates konverentsikogumikes

1. Kaljuvee, T.; Hälvin, H.; Pototski, A.; Kuusik, R (2013). Laboratory scale granulation of oil shale ashes. In: *Proceedings of the 6th Int. Granulation Conference: The 6th International Granulation Conference*, Sheffield, United Kingdom; June 26-28, 2013. 10p. USB. , 2013.
2. Klimova, I.; Mikli, V.; Kaljuvee, T. (2013). Upgrading the crush strength of ammonium nitrate prills by coating with limestone or dolomite powder. In: *Proceedings of the 6th Int.*

Granulation Workshop, Granulation Conference.: The 6th Int. Granulation Workshop, Granulation Conference. Sheffield, England. 26th-28th June 2013. 7p. USB. , 2013.

5.2 Konverentsiteesid, mis ei kuulu valdkonda 5.1

1. Klimova, I.; Kaljuvee, T. (2013). Ammooniumnitraadi graanulite modifitseerimine lubjakivijahust katendi abil. In: XXXIII Eesti Keemiapäevad, Teaduskonverentsi teesid.: XXXIII Eest Keemiapäevad. Tallinn, Eesti. 11. oktoober 2013.
2. Podoba, R.; Kaljuvee, T.; Stubna, I.; Podobnik, L. (2013). Application of thermal analysis for historical building ceramics. In: Book of Abstracts of the 2nd Central and Eastern European Conference on Thermal Analysis and Calorimetry: The 2nd Central and Eastern European Conference on Thermal Analysis and Calorimetry. Vilnius, Lithuania. 28th-30th August 2013. 2013, 291.
3. Otto, K.; Oja Acik, I.; Krunks, M.; Tõnsuaadu, K. (2013). Au JA Ag Nanoosakeste saamisekskasutatavate lähteainete HAuCl₄·3H₂O ja AgNO₃ termilise lagunemise uurimine. In: Teaduskonverentsi teesid: XXXIII Eesti Keemiapäevad, Tallinn, 11.10.2013. , 2013, 55.
4. Viipsi, K.; Sjöberg, S.; Tõnsuaadu, K.; Shchukarev, A. (2013). Cd²⁺ and Zn²⁺ sorption on apatite in the presence of EDTA and humic substance . In: Proceedings of the 16th International Conference on Heavy Metals in the Environment: 16th International Conference on Heavy Metals in the Environment, Rome, 23-27 September 2012. , 2013, (E3S Web of Conferences ; 1).
5. Kuusik, R.; Uibu, M.; Kirsimäe, K.; Pototski, A.; Meriste, T. (2013). Joint efforts for utilization of oil shale ash in new areas . In: International Oil Shale Symposium: International Oil Shale Symposium, Tallinn, Estonia, June 10-13, 2013. Tallinn:, 2013. P. 52.
6. Kaljuvee, T.; Hälvin, H., Pototski, A.; Kuusik, R. (2013). Laboratory-scale granulation of oil shale ashes. In: Abstract Book of the 6th Int. Granulation Workshop, Granulation Conference. Sheffield, England. 26th-28th June 2013.:, 2013, 63.
7. Meriste, T.; Trikkel, A.; Kuusik, R. TGA-FTIR analysis of the oxidation kinetics of oil shale // International Oil Shale Symposium, Tallinn, Estonia, June 10-13, 2013. Tallinn:, 2013. P. 53-54
8. Klimova, I.; Kaljuvee, T.; Mikli, V.; Trikkel, A. (2013). Influence of some lime-containing additives on the thermal behavior of urea. Journal of Thermal Analysis and Calorimetry, 111(1), 253 - 258.
9. Velts, O.; Uibu, M.; Kallas, J.; Kuusik, R. (2013). Co-utilization of CO₂ and Oil Shale Combustion Wastes for Production of PCC-type Material. In: Program & Abstracts: ICCDU XII, 12th International Conference on Carbon Dioxide Utilization, June 23-27, 2013, Alexandria, VA, USA. , 2013, 230.
10. Raado, L.-M.; Hain, Ti.; Somelar, P.; Uibu, M. (2013). Mineralogical composition and strength formation of oil shale ash based building composites. In: International Oil Shale Symposium: International Oil Shale Symposium, Tallinn, Estonia, June, 10-13, 2013. Tallinn, Estonia:, 2013, 58.
11. Tõnsuaadu, K.; Gruselle, M.; Moussa, J.; Villemin, D.; Maaten, B.; Kanger, T. (2013). Modified calcium apatites as new catalysts in organic synthesis. In: International Symposium on Inorganic and Environmental Materials 2013, Programm and abstracts, October 27-31, 2013, Rennes, France: 2013, 277.

12. Mere, A.; Oja Acik, I.; Otto, K.; Krunks, M.; Tõnsuaadu, K. (2013). Pihustuspürolüüsi meetodil sadestatud CuInS₂ kilede lähteainete termiline lagunemine. In: Teaduskonverentsi teesid: XXXIII Eesti Keemiapäevad, Tallinn, 11.10.2013. Tallinn: Eesti Keemia Selts, 2013, 46.
13. Stankeviciute, Z.; Tõnsuaadu, K.; Bogdanoviciene, I.; Kareiva, A. (2013). Precursor for Calcium Hydroxyapatite: Thermal Analysis of Xerogel Prepared with DCTA as Complexing Agent. In: Conference abstracts: European Symposium on Biomaterials and related Areas, 23.-24. April 2013, Weimar, Germany. www.dgm.de/biomat., 2013, 1.
14. Tõnsuaadu, K.; Bogdanoviciene, I.; Traksmäa, R. (2013). Purity test of precipitated apatites by TG/DTA/EGA-MS. In: Book of Abstracts 2nd Central and Eastern European Conference on Thermal analysis and Calorimetry: 2nd Central and Eastern European Conference on Thermal analysis and Calorimetry, 27-30 August, 2013, Vilnius, Lithuania. Vilnius., 2013, 232.
15. Beganskiene, A.; Stankeviciute, Z.; Malakauskaite, M.; Bogdanoviciene, I.; Tõnsuaadu, K.; Kareiva, A. (2013). Sol-Gel Approach to the Calcium Phosphate Nanocomposites (ICACC-S7-P091-2013, Daytona Beach, Florida). In: 37th International Conference and Exposition on Advanced Ceramics and Composites, Abstracts Book: 37th International Conference and Exposition on Advanced Ceramics and Composites, Daytona Beach, Florida, USA, January 27 - February 1, 2013.. , 2013, 102.
16. T. Kaljuvee, H. Hälvin, V. Loide, R. Kuusik (2013). Some possibilities of granulation of soil shale ashes. In: International oil shale symposium: International oil shale symposium, Tallinn, Estonia June 10-13, 2013. , 2013, 73 - 74.
17. Irha, N.; Jefimova, J.; Hain, T.; Einard, M.; Reinik, J.; Piirsalu, E. Some leaching characteristics of Estonian oil shale ash based construction composites. In: International oil shale symposium: International oil shale symposium, Tallinn, Estonia June 10-13, 2013. , 2013, 70 - 71.
18. Ivask, J.; Shogenova, A.; Kuusik, R.; Shogenov, K. Oil shale ash a main source of industrial CO₂ emissions in Estonia: prospects for CO₂ storage and use. In: International oil shale symposium: International oil shale symposium, Tallinn, Estonia June 10-13, 2013. 71.
19. Viikna, A.; Süld, T.-M.; Kuusik, R. Prospects for use of oil shale fly ash as filler in polymeric compounds. In: International oil shale symposium: International oil shale symposium, Tallinn, Estonia June 10-13, 2013. 77.
20. Tõnsuaadu, K.; Bogdanoviciene, I.; Traksmäa, R.; Kareiva, A. (2013). Synthesis of cationic substituted biomimic apatites by precipitation. In: International Symposium on Inorganic and Environmental Materials 2013, Programm and abstracts, October 27-31, 2013, Rennes, France., 2013, 206.
21. Tamm, K.; Kuusik, R.; Uibu, M.; Kallas, J.; Priks, H. (2013). The sulfur intermediate oxidation forms in oil shale ash suspension. TÜ ja TTÜ doktorikooli "Funktsionaalsed materjalid ja tehnoloogiad" neljas teaduskonverents, Tallinn, 07.-08. märtsil. , 2013.
22. Stankeviciute, Z.; Tõnsuaadu, K.; Bogdanoviciene, I.; Kareiva, A. (2013). Thermal Analysis of Xerogel for Calcium Hydroxyapatite Thin Films Preparation. In: Book of Abstracts of the 15th International Conference-School Advanced materials and technologies: 15th International Conference-School "Advanced materials and technologies, 27-31 August 2013, Palanga, Lithuania. Technologija, Kaunas, 2013, 128.

23. Otto, K.; Krunk, M.; Oja Acik, I.; Tõnsuaadu, K. (2013). Thermal decomposition study of $\text{HAuCl}_4 \cdot 3\text{H}_2\text{O}$ and AgNO_3 as precursors for plasmonic metal nanoparticles. In: Central and Eastern European Committee for Thermal Analysis and Calorimetry (CEEC-TAC2) 2013, Vilnius, 27-30.08.2013., 2013, 298.
24. Klimova, I.; Mikli, V.; Kaljuvee, T. (2013). Upgrading the crush strength of ammonium nitrate prills by coating with limestone or dolomite powder. In: Abstract Book of the 6th Int. Granulation Workshop, Granulation Conference: The 6th Granulation Workshop, Granulation Conference. Sheffield, England. 26th-28th June 2013.. , 2013, 102.
25. Tamm, K.; Uibu, M.; Kuusik, R.; Kallas, J. (2013). Väävliühendid põlevkivituha märgkarboniseerimisel - Suuline ettekanne. In: XXXIII Eesti Keemiapäevad, Teaduskonverentsi teesid: XXXIII Eesti Keemiapäevad, Tallinn, 11. oktoober 2013. Tallinn:, 2013, 78.
26. Kaljuvee, T.; Stubna, I.; Somelar, P.; Mikli, V.; Kuusik, R. (2013). Thermal behavior of some Estonian clays and their mixtures with oil shale ash additive. In: Central and Eastern European Committee for Thermal Analysis and Calorimetry (CEEC-TAC2) 2013, Vilnius, 27-30.08.2013, 231.

6.7 Muu loome

1. Siirde, A.; Veiderma, M.+ eksperdid viielt maalt (2013). Strategy and Capacity Building for fossil fuel fired power plants in the Maghreb countries. Final report 2013, VITO. Belgie, pp. 195+21 append. (Under the authority of World Bank).

2.10 Struktuuriüksuses järel doktorina T&A-s osalenud isikute loetelu (*ETIS-e kaudu esitatud taotluste alusel*)

Merit Nigol (Kindsigo) Põlevkivituha taaskasutus: pidevprotsesside arendus happeliste gaaside emissiooni vähendamiseks ja sadestatud kaltsiumkarbonaadi saamiseks (1.03.2012 - 28.02.2015)

Irma Bogdanoviciene, Sorption of bio-molecules on synthetic Ca hydroxyapatites doped with metal ions (15.10.2012-14.10.2015)