

KEEMIA- JA MATERJALITEHNOLOOGIA TEADUSKOND
POLÜMEERMATERJALIDE INSTITUUT
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2012

1. Instituudi struktuur

Polümeermaterjalide instituut, Department of Polymer Materials
Instituudi direktori kohusetäitja Andres Krumme

- Polümeeride tehnoloogia õppetool, Chair of Polymer Technology, Andres Krumme
- Puidutöötlemise õppetool, Chair of Woodworking, Jaan Kers
- Tekstiilitehnoloogia õppetool, Chair of Textile Technology, Anti Viikna
- Põlevkivi ja taastuvkütuste teaduslaboratoorium, Laboratory of Oil Shale and Renewables Research, Hans Luik
- Mööbli ja puitmaterjalide katselaboratoorium, Laboratory for Furniture and Wood Materials Testing
- Tekstiili katselaboratoorium, Laboratory for Textile Testing

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

(NB! punktid 2.1- 2.6 täidab struktuuriüksus)

2.1 struktuuriüksuse koosseisu kuuluvate uurimisgruppide

2.1.1 teadustöö kirjeldus *(inglise keeles)*;

Tekstiilitehnoloogia õppetool, Chair of Textile Technology

Scientific activities of the chair of textile technology are very closely connected with scientific interests of the chair of polymer technology and laboratory of inorganic materials. For example professor A.Viikna participates in investigations of “Carbon nanotube reinforced electrospun nanofibres and yarns“ AR12135, advised by professor Andres Krumme (16.03.2012 - 31.12.2014) and „Basics of new utilization processes for oil shale combustion solid wastes“ AR10127, advised by leading research scientist Rein Kuusik (01.01.2011 – 30.06.2013).

Polümeeride tehnoloogia õppetool, Chair of Polymer Technology

1. (ETF8134, Ermos78, SS012) Sustainable thermoplastic polymers and composites are developed and investigated to partly or fully replace non-renewable-resources-based materials for melt processing technologies. Cellulose appears to be a nearly unlimited renewable resource for polymeric materials. Discovery of new dissolution processes in ionic liquids opens several new routes for functionalization of cellulose. Thermoplastic cellulose derivatives can be prepared without use of plasticizers. Adhesion and mechanical properties of cellulose in composites with synthetic polymers as polyolefins and polylactides can be improved. Effect of constituents and functionalization agents on rheology, crystallization behaviour, morphology and mechanical properties of the novel thermoplastic materials and composites are investigated.
2. (AR12135) Main goal of the project is to develop and industrialize a technological process for production of ultra-strong and functionalised polymer nanofibres and yarns for various

applications. The process combines electro-spinning of polymers with carbon nanotube (CNT) doping and additional functionalization tools. As a result pure nanofibres, nanofibre yarns and fabrics are produced. The main applications of the novel materials are: dynamically adjustable pore size filter for special filtering applications; substrates for cell growth; ultra-strong fabric for reinforcement of plastic film laminates; yarns for special textiles having exceptional strength and special properties as piezoactivity, conductivity and shielding capacity.

Puidutöötlemise õppetool, Chair of Woodworking

Scientific research topics of Chair of woodworking in 2012 were wood protection by different impregnation methods and agents, study of the birch plywood properties and development of wood plastic composites. Our scientific research collaboration partners are Aalto University Department of Forest Products Technology, Norwegian Forest and Landscape Institute, Estonian University of Lifescience.

To prevent degradation caused by different microorganisms, UV radiation and moisture, wood products are treated with different technologies – biocidal or non-biocidal systems. In cooperation with Norwegian Scientists the potential alternatives for biocidal systems based on water-borne copper-rich systems used in Royal process were investigated.

The variation in leachability of wood preservatives from impregnated Scots pine a (*Pinus sylvestris* L.) different stand was studied in another project in cooperation with Norwegian Forest and Landscape institute.

The new impregnation emulsion was tested against the emulsion prepared from widely used “Tanalith E” wood preservative.

Põlevkivi ja taastuvkütuste teaduslaboratoorium, Laboratory of Oil Shale and Renewables Research

1. (T028) Liquefaction and upgrading of Estonian fossil and renewable fuels and fuel blends with the aim of their more rational and appropriate utilisation will be investigated. Scientific and technological fundamentals to maximum conversion of oil shale, peat, varieties of biomass and plastic wastes into non-conventional petroleum by using novel thermal dissolution, hydrogenation and co-processing methods will be created. Bi- and multilateral interactions occurring between components at sub- and supercritical extraction and at upgrading of the viscous extracts by hydrogenation will be investigated. Probable positive synergistic effects in the yield and composition of the liquid product will be described. Mathematical models will be deduced for approximate description of the joint effect of the main factors on the yield and composition of the products in the complicated processes. The results obtained represent the science-based fundamentals for upgrading available natural fuel resources.
2. (ETF9331) Regularities of thermochemical liquefaction and upgrading of the dictyonema oil shale with the aim of estimating its potential as a source for synthetic petroleum will be investigated. As a conversion method supercritical extraction in autoclave in the presence of various solvents and reagents is used. The effect of supercritical water, benzene, hexane, methanol, ethanol and acetone on products yield and composition will be investigated. In order to obtain the maximum yield of oil rich in hydrocarbons parameters of kerogen liquefaction process (temperature, liquefaction time, pressure in autoclave and weight ratio

of initial substances) will be largely varied and some selected reagents (H-donors, NaOH, zinc) are added to evoke the hydrogenation, cracking and other reactions. Physical-chemical and technological fundamentals for the sustainable utilisation of the huge reserve of so far industrially unused oil shale type will be created.

3. (AR12004) The project is a continuation of the competence in the field of oil shale liquefaction via complex investigations leading to the new technologies, and the direct goals of the project include working out novel technological fundamentals of shale oil production and complex upgrading scheme of liquid, gaseous and solid products formed in thermochemical destruction of different oil shales.

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

Tekstiilitehnoloogia õppetool, Chair of Textile Technology

1. (AR12135) The part of results of scientific investigations of professor A. Viikna are described under Chair of Polymer Technology.
2. (AR10127) The scientific investigation „Basics of new utilization processes for oil shale combustion solid wastes” deals with the problem, how to use fly ash of combustion of oil shale as additive to polyethylene (PE) for formation new, more cheap composite materials. Investigated the possibility of blending of oil shale ashes with PE with compounder. Obtained materials were tested (density, MFI, thermal analysis, tensile strength etc.) and selected the best composites for producing film.

Polümeeride tehnoloogia õppetool, Chair of Polymer Technology

1. (ETF8134, Ermos78, SS012) Composites of low-density polyethylene (LDPE) and polylactic acid (PLA) with cellulose (CELL) and its derivatives were under investigation. Crystallization behaviour of PLA/CELL and LDPE/CELL composites was studied by differential scanning calorimetry (DSC) and polarized light microscopy equipped with hot-stage. For all PLA/CELL samples cold crystallization (increase of structural order during annealing) at around 130°C was observed. Cold crystallinity is strongly affected by cellulose content: the higher the cellulose content, the higher is the cold crystallinity of the samples. Rheology of blends of LDPE and mixed esters of CELL prepared by functionalisation in ionic liquids was analysed. The best substituents and optimum functionalisation parameters of CELL for improved melt stiffness of the composites were found.
2. (AR12135) novel concepts for producing yarns from nanofibres produced by electrospinning were successfully tested. Rheology of electrospinning solutions containing certain homopolymers and copolymers with carbon nanotubes was evaluated and electrospinning conditions were clarified. Chemical modification and bonding of the carbon nanotubes with polymeric constituents was explained.

Puidutöötlemise õppetool, Chair of Woodworking

The research results of treatment of wood with natural product chitosan showed low resistance against fungal attack. However, in combination with an oil treatment a high resistance against brown rot attack could be shown. In contrast, white rot attack could not be prevented with chitosan in combination with oil. Wood samples treated with the natural product tannin and in combination with an oil treatment showed good antifungal properties when exposed to brown rot. However, white rot attack could not be prevented. Scanimp provides high antifungal effectiveness and as an organic biocide could be an alternative product for copper-based products used in Royal process. Royal process has a great environmental advantage; it significantly reduces the leaching of copper in use

The wood preservatives leachability study showed the influence of the harvesting site and wood variables on the leaching behaviour of copper-based preservatives. A significant correlation between vertical stem position of the samples and the emission of Cu from preservatives was exhibited. Preservatives leached more from the lowest part of the stem.

The new impregnation emulsion was tested against the emulsion prepared from widely used "Tanalith E" wood preservative. The most effective emulsion against wood rotting fungi penetration agent had the composition of 3.5% boron compounds, 2% rapeseed oil, 2% acid oil. Mass-loss caused by fungal decay was after leaching less than 3% (according to EN113). This research work was supported by EAS project "Improved impregnating technology for pinewood protection". ERDF project code EU21307.

Scientific research results were published in Journal of Materials Science and Agronomy Research 8th DAAAM Baltic Industrial Engineering Conference proceedings held in TUT from 19-21st of April 2012. The scientific work on probation of two master students of Woodworking Chair in Norway afore mentioned institution was summarized in two master thesis's defended in spring 2012. On the basis of their research results two papers were published in conference proceedings.

Põlevkivi ja taastuvkütuste teaduslaboratoorium, Laboratory of Oil Shale and Renewables Research

1. (T028) The effects of solvent type, temperature and duration on the yield and composition of the decomposition products in supercritical extraction and low-temperature pyrolysis (350-420 °C) of oil shale, biomass varieties and plastic wastes, and their blends have been investigated. As a result, the yield of liquid products from organic matter has been increased about 1.5 times in comparison with the being in use semicoking. A mathematical model has been created for description of the thermobituminization kinetics in both open retorts and autoclaves. Effect of novel catalysts and operating conditions on the yield and quality of the hydrogenated heavy oil and thermobitumen has been characterized in a batch autoclave. Mathematical model is developed which constants describe the oil yield and loss of oil by adsorption on the solid residue in different procedures and types of mineral matter. A hypothesis is created for mathematical modeling of the extent of synergy in co-pyrolysis.
2. (ETF9331) In 2012 analysis of the source Dictyonema oil shale was performed by establishing contents of moisture, ash, organic matter, sulfur and its bonding forms. Acid treatment, dry pyrolysis and thermal dissolution of the source rock using water, benzene and n-hexane in supercritical conditions has been carried out varying with temperature, process duration and rock-to-solvent ratio. Material balance of liquid, gaseous and solid products formed resulting from thermal dissolution was calculated. Group and individual composition of liquid products was investigated using thin-layer chromatographic and GC-MS-techniques. The hypothesis that supercritical dissolution can give 2-3 times higher yield of the liquid product compared with dry pyrolysis (semicoking) was demonstrated.
3. (AR12004) Thermal dissolution of the Kukersite oil shale in autoclaves and flow reactor has been performed and higher than 70% oil yields per organic matter obtained. Primary oil was subjected to the catalytical hydrogenation and as a result hydrocarbons content of heteroatomic compounds decreased. Chemical characterization of oils and solid residues has been represented. Regularities of sulphur transformation have been elucidated.

2.2 Uurimisgrupi kuni 5 olulisemat publikatsiooni läinud aastal.

- Johannes, I.; Luik, H.; Bojesen-Koefoed, J. A.; Tiikma, L.; Vink, N.; Luik, L. (2012). Effect of organic matter content and type of mineral matter on the oil yield from oil shales. *Oil Shale*, 29(3), 206 - 221.

- Krasulina, J.; Luik, H.; Palu, V.; Tamvelius, H. (2012). Thermochemical co-liquefaction of Estonian kukersite oil shale with peat and pine bark. *Oil Shale*, 29(3), 222 - 236.
- Šumigin, D.; Tarasova, E.; Krumme, A.; Viikna, A. (2012). Influence of cellulose content on thermal properties of poly(lactic acid)/cellulose and low-density polyethylene/cellulose composites. *Proceedings of the Estonian Academy of Sciences*, 61(3), 237 - 244.
- Menind, Andres; Oper, Liis; Kers, Jaan; Melts, Indrek; Olt, Jüri (2012). Preliminary investigation of technological, physical and economic parameters of herbaceous biomass briquettes. *Lecture Notes in Information Technology*, 9, 134 - 140.
- Aruniit, A.; Kers, J.; Krumme, A.; Poltimäe, T.; Tall, K. (2012). Preliminary study of the influence of post curing parameters to the particle reinforced composite's mechanical and physical properties. *Journal of Materials Science of Kaunas University of Technology*, 12(3), 258 - 261.

2.3 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustest.

Hans Luik – Commendation Spent Shaler (Colorado, USA 16.10.2012)

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

Välisakadeemiade või muude oluliste T&A-ga seotud välisorganisatsioonide liikmed instituudis puuduvad.

2.5 Aruandeaasta tähtsamad T&A finantseerimise allikad.

- T028, Põlevkivi ja kütuste segude termokeemilise töötlemise uued tehnoloogiad, Hans Luik (2009 – 2014)
- AR12004, Energiatehnoloogia II, Põlevkivi maksimaalse vääristamise alused, Hans Luik (1.01.2012–30.06.2015)
- AR12135, Materjalitehnoloogia, Carbon nanotube reinforced electrospun nanofibres and yarns, Andres Krumme (16.03.2012 - 31.12.2014)
- AR10127, SA Arvhimedese toetus, Põlevkivi põletamisega kaasnevate tahkjäätmete uute kasutusala alused, Rein Kuusik (01.01.2012 - 31.12.2014)
- ETF8134, Uuadsed bimodaalse koostisega polüetüleenid: makromolekulaarsete koostisosade ja hargnemiste mõju kristallisatsioonile, reoloogiale ja mehaanilistele omadustele, Andres Krumme (2010 – 2013)
- ETF9331, Diktüoneema põlevkivi orgaanilise aine vedeldamine superkriitiliste lahustite ja reagentidega, Hans Luik (2012–2015)
- ERMOS78, Flow-induced crystallization and rheology of polyester amides and their composites Illia Krasnou (1.10.2011 - 30.09.2013)
- SS011, SS012 – EAS innovatsiooniosakud ja katsetusteenused (Jaan Kers, Andres Krumme)

2.6 Soovi korral lisada aruandeaastal saadud T&A-ga seotud tunnustusi (va punktis 2.3 toodud tunnustused), ülevaate teaduskorralduslikust tegevusest, teadlasmobiilsusest ning anda hinnang oma teadustulemustele.

Teaduskorralduslik tegevus:

- Prof. James W. Bungeri (USA) loengud Tallinnas ja Kohtla-Järvel põlevkivi uurimise ja töötlemistehnoloogia teemadel
- Töötuba Teherani Ülikoolis (20 tundi) siinse laboratooriumi kogemuste tutvustamiseks põlevkiviüuringute valdkonnas ja kukersiidi tööstusliku pürolüüsi teemadel

Teadlasmobiilsus

Hans Luik, Lea Luik - esinetud 32. Põlevkivi Sümpoosionil Colorados (32nd Oil Shale Symposium, October 15-17, 2010, Colorado School of Mines, Colorado, USA)

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

- Haridus- ja Teadusministeerium
 - sihtfinantseeritavad teemad:
T028, Põlevkivi ja kütuste segude termokeemilise töötlemise uued tehnoloogiad, Hans Luik (2009 – 2014)
 - baasfinantseerimise toetusfondist rahastatud projektid (sh TTÜ tippkeskused):
 - riiklikud programmid:
 - Teiste ministeeriumide poolt rahastatavad riiklikud programmid:
 - Uurija-professori rahastamine:
 - SA Eesti Teadusfond/Eesti Teadusagentuur
 - grantid:
ETF8134, Uudsed bimodaalse koostisega polüetüleenid: makromolekulaarsete koostisosade ja hargnemiste mõju kristallisatsioonile, reoloogiale ja mehaanilistele omadustele, Krumme Andres (2010 – 2013)
ETF9331, Diktüoneema põlevkivi orgaanilise aine vedeldamine superkriitiliste lahustite ja reagentidega, Hans Luik (2012–2015)
 - ühisgrandid välisriigiga:
 - järel doktorite grantid (SA ETF ja Mobilitas):
ERMOS78 , Krasnou Illia, FLOW-INDUCED CRYSTALLIZATION AND RHEOLOGY OF POLYESTER AMIDES AND THEIR COMPOSITES (1.10.2011 - 30.09.2013)
 - tippteadlase grantid (Mobilitas):
 - Ettevõtluse Arendamise SA
 - eeluuringud:
 - arendustoetused:
 - SA Archimedesega sõlmitud lepingud
 - infrastruktuur (nn „mini-infra“, „asutuse infra“):

ÜLTAP15-1, Nanostruktuursete komposiitmaterjalide komplekslabor, Andres Krumme (1.01.2010 - 7.07.2013)

– Eesti tippkeskused:

– riiklikud programmid:

AR12004, Energiatehnoloogia II, Põlevkivi maksimaalse vääristamise alused, Hans Luik (1.01.2012–30.06.2015)

AR12135, materjalitehnoloogia, Carbon nanotube reinforced electrospun nanofibres and yarns, Andres Krumme (16.03.2012 - 31.12.2014)

– muud T&A lepingud:

- SA Keskkonnainvesteeringute Keskusega sõlmitud lepingud:

- Siseriiklikud lepingud:

Lep12009, Segaolmejäätmetest toodetava jäätmekütuse RDF potentsiaal, Viikna Anti (13.10.2011 - 13.01.2012)

- EL Raamprogrammi projektid:

- Välisriiklikud lepingud:

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

Välbe, Raul; Mäeorg, Uno; Lõhmus, Ants; Reedo, Valter; Koel, Mihkel; Krumme, Andres; Kessler, Vadim; Hoop, Andres; Romanov, Alexey E. (2012). A novel route of synthesis of sodium hexafluorosilicate two component cluster crystals using BF₄⁻ containing ionic liquids. *Journal of Crystal Growth*, 361, 51 - 56.

Johannes, I.; Luik, H.; Bojesen-Koefoed, J. A.; Tiikma, L.; Vink, N.; Luik, L. (2012). Effect of organic matter content and type of mineral matter on the oil yield from oil shales. *Oil Shale*, 29(3), 206 - 221.

Krasulina, J.; Luik, H.; Palu, V.; Tamvelius, H. (2012). Thermochemical co-liquefaction of Estonian kukersite oil shale with peat and pine bark. *Oil Shale*, 29(3), 222 - 236.

Šumigin, D.; Tarasova, E.; Krumme, A.; Viikna, A. (2012). Influence of cellulose content on thermal properties of poly(lactic acid)/cellulose and low-density polyethylene/cellulose composites. *Proceedings of the Estonian Academy of Sciences*, 61(3), 237 - 244.

Menind, Andres; Oper, Liis; Kers, Jaan; Melts, Indrek; Olt, Jüri (2012). Preliminary investigation of technological, physical and economic parameters of herbaceous biomass briquettes. *Lecture Notes in Information Technology*, 9, 134 - 140.

Aruniit, A.; Kers, J.; Krumme, A.; Poltimäe, T.; Tall, K. (2012). Preliminary study of the influence of post curing parameters to the particle reinforced composite's mechanical and physical properties. *Journal of Materials Science of Kaunas University of Technology*, 12(3), 258 - 261.

1.2

Johannes, I.; Tiikma, L.; Luik, H.; Tamvelius, H.; Krasulina, J. (2012). Catalytic thermal liquefaction of oil shale in tetralin . International Scholarly Research Network (ISRN), Chemical Engineering, 2012(ID 617363), 1 - 11.

Kaps, T.; Reiska, R.; Kallavus, U.; Koolme, M.; Luga, Ü.; Kers, J. (2012). Effective protection of pinewood against fungal attack. Agronomy Research, 10, 123 - 129.

Menind, Andres; Oper, Liis; Hovi, Mart; Kers, Jaan; Tutt, Marti; Kikas, Timo (2012). Pretreatment and usage of pulp and paper industry residues for fuels production and their energetic potential . Agronomy Research, 10, 149 - 155.

1.3

2.1

2.2

3.1

Menind Andres, Oper Liis, Nurk Liina (2012). Preliminary investigation of physical, chemical and technological parameters of biogasification and briquetting of fractionated silage. 11th International Scientific Conference ENGINEERING FOR RURAL DEVELOPMENT Proceedings (580 - 585).Latvia University of Agriculture

Luyima, A.; Zhang, L.; Kers, J.; Schuman, T. (2012). Control of Gas Emission during Pyrolysis of Waste Printed Wiring Boards. In: EPD Congress 2012: Held during the TMS 2012 Annual Meeting & Exhibition, Orlando, Florida, USA, 2012. (Toim.) L. Zhang, J. A. Pomykala, A. Ciftja . Wiley, TMS, 2012, 237 - 246.

Kaps, T.; Reiska, R.; Kallavus, U.; Luga, Ü.; Kers, J. (2012). Development of emulsion and impregnation technology for wood bioprotection. In: Proceedings of the 8th International Conference od DAAAM Baltic Industrial Engineering 19-21st April 2012, Tallinn, Estonia: 8th International Conference of DAAAM Baltic Industrial Engineering, Tallinn, Estonia, 19-21 april 2012. (Toim.) T. Otto. Tallinn: Tallinna Tehnikaülikooli Kirjastus, 2012, 627 - 632.

Piirlaid, M.; Matsi, M.; Kers, J.; Rohumaa, A.; Meier, P. (2012). Effect of birch veneer processing factors on adhesive bond shear strength. In: Proceedings of the 8th International Conference od DAAAM Baltic Industrial Engineering 19-21st April 2012, Tallinn, Estonia: 8th International Conference of DAAAM Baltic Industrial Engineering, Tallinn, Estonia, 19-21 april 2012. (Toim.) T. Otto. Tallinn: Tallinna Tehnikaülikooli Kirjastus, 2012, 705 - 710.

Kängsepp, K.; Larnøy, E.; Kers, J.; Meier, P. (2012). Leachability of wood protection agents from impregnated pine wood. In: Proceedings of the 8th International Conference od DAAAM Baltic Industrial Engineering 19-21st April 2012, Tallinn, Estonia: 8th International Conference of DAAAM Baltic Industrial Engineering, Tallinn, Estonia, 19-21 april 2012. (Toim.) T. Otto. Tallinn: Tallinna Tehnikaülikooli Kirjastus, 2012, 663 - 667.

Menind, A.; Križan, P.; Šooš, L.; Matuš, M.; Kers, J. (2012). Optimal conditions for valuation of wood waste by briquetting. In: Proceedings of 8th International Conference of DAAAM Baltic Industrial Engineering, Tallinn, Estonia, 19-21st of April 2012: 8th International Conference of DAAAM Baltic Industrial Engineering, Tallinn, Estonia, 19-21st of April 2012. (Toim.) T. Otto.

Tallinn: Tallinn University of Technology Press, 2012, 187 - 192.

Liibert, L.; Treu, A.; Kers, J.; Meier, P. (2012). Potential eco-friendly wood protection systems used in royal process. In: Proceedings of the 8th International Conference of DAAAM Baltic Industrial Engineering 19-21st April 2012, Tallinn, Estonia: 8th International Conference of DAAAM Baltic Industrial Engineering, Tallinn, Estonia, 19-21 April 2012. (Toim.) T. Otto. Tallinn: Tallinna Tehnikaülikooli Kirjastus, 2012, 674 - 679.

3.2

Süld, T.-M.; Kaljuvee, T.; Viikna, A. (2012). Studying of internal and rheological properties of polyethylene-oil shale ash composites . 28th International Conference of Polymer Processing Society PPS-28, Pattaya, Thailand, December 11-14, 2012. Pattaya, Thailand:, 2012, - - - .
[ilmumas]

3.3

4.1

5.1

2.9 Struktuuriüksuses kaitstud doktoriväitekirjade loetelu (*NB! struktuuriüksus lisab struktuuriüksuse töötaja juhendamisel mujal kaitstud doktoriväitekirjade loetelu*)

Aleksei Zaidentsal, polümeermaterjalide instituut, Põlevkivi ja taastuvkütuste teaduslaboratoorium
Teema: *Investigation of Estonian Oil Shale Thermobituminization in Open and Closed System*
(Termobituumeni moodustumine Eesti põlevkivist avatud ja suletud süsteemis)
Juhendajad: vanemteadur Ille Johannes ja Jüri Soone
Kaitstes: 25.09.2012
Omistatud kraad: filosoofiadoktor (keemia ja keemiatehnika)

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

Krasnou Illia, FLOW-INDUCED CRYSTALLIZATION AND RHEOLOGY OF POLYESTER AMIDES AND THEIR COMPOSITES (1.10.2011 - 30.09.2013)

2.11 Struktuuriüksuses loodud tööstusomandi loetelu

EE05560B1

Komposiitkile

Patent välja antud: 15.08.2012

Autorid: Anti Viikna, Andres Krumme, Tiia-Maaja Süld

Omanik: TTÜ

EE05564B1

Meetod plastjäätmete ja põlevkivi koostamiseks

Patent välja antud: 15.08.2012

Autorid: Arvi Poobus, Laine Tiikma, Allan Vrajer, Tõnu Pihu, Siim Link.

Omanik: TTÜ

3 Struktuuriüksuse infrastruktuuri uuendamise loetelu (*summa eurodes*)

PV007363, Survevaluseade BabyPlast 60 P, 2.05.2012 (25 335,00)

PV007371, HAAKE MiniCTW mikrokompauder, 24.05.2012 (47 026,00)

PV007372, Agilent PL-GPC 220, kõrgtemp., 28.05.2012 (139 399,87)

PV007442, Kileliin (TEACH-LINE) - IV-110, 7.09.2012 (54 000,00)

PV007513, Tsentrifuug Hetich EBA 21, 10.12.2012 (2 248,00)