Adam Mickiewicz University in Poznań

Doctoral School of Exact Sciences AMU

Prof. Richard Laine

University of Michigan, Ann Arbor (USA)

Sustainable Materials from Agricultural waste

Field of science	chemistry and material engineering
Teaching method	Lecture with a multimedia presentation of selected issues, Discussion
Language	English
Numbers of hours	15
Aims of the course	The aim of this lecture is to explore innovative methods for transforming agricultural waste into sustainable, high-value materials. Prof. Laine will discuss how waste byproducts, such as rice husk ash or other biomass residues, can be converted into functional silica-based materials for applications in protective coatings, ceramics, and composites. By developing advanced processing technologies, this research contributes to reducing environmental impact while creating sustainable alternatives to conventional materials. The lecture will highlight both the scientific principles behind these transformations and their practical implications for industry and sustainability.
Course contents	Lecture notes, slide copy
Prerequisites and co-requisites	Lecture for PhD students of chemistry and related disciplines

Learning outcomes	
On completion of the course PhD candidates will be able to:	**Assessment mode**
	test

Literature

1. R.M. Laine, K.Y. Blohowiak, T.R. Robinson, M.L. Hoppe, P. Nardi, J. Kampf, J. Uhm, "Synthesis of Novel, Pentacoordinate Silicon Complexes from SiO_2," Nature **1991**, *353*, 642-4.
2. J. C. Marchal, D. J. Krug, P. McDonnell, R. M. Laine, "A low cost, low energy route to solar grade silicon from a sustainable source," *Green Chemistry* **2015**, 17, 3931–3940. DOI: 10.1039/C5GC00622H
3. R. M. Laine, P. Doan, J. C. Furgal, D. Pan, E. Yi, V. Popova, "Avoiding Carbothermal Reduction: Distillation of Alkoxysilanes from Biogenic, Green, and Sustainable Sources Angew. Chem. Int. Ed. **2016**, *128*, 1077-1081. https://doi.org/10.1002/ange.201506838
4. E. Yi, C. E. Hyde, K. Sun, and R. M. Laine, "Escaping Carbothermal Reduction. Fumed Silica From Sustainable, Green Sources Without First Having to Make $SiCl_4$," Chem. Eur. J. **2016**, 22, 2257-2260. https://doi.org/10.1002/chem.201505056
5. E. Temeche, M. Yu, R. M. Laine, "Silica depleted rice hull ash (SDRHA), an agricultural waste, as a high-performance hybrid lithium-ion capacitor," *Green Chemistry*, **2020**, **22**, 4656-4668. https://doi.org/10.1039/D0GC01746A
6. Zhang, E. Temeche, R. M. Laine, "Li_xSiON Polymer Precursors Derived from Agricultural Waste. Towards All Solid-State Batteries (ASSBs)," *Green Chemistry* **2020***, 22,* 7491-7505. DOI:10.1039/D0GC02580A
7. M. Yu, R. M. Laine, "Adjusting SiO_2:C mole ratios in rice hull ash (RHA) to control carbothermal reduction to nanostructured SiC, Si_3N_4 or Si_2N_2O composites." *Green Chemistry* 2021*,* ***23***, 7751-7762. https://doi.org/10.1039/d1gc02084f
8. M. Yu, E. Temeche, S. Indris, W. Lai, R. M. Laine, "Silicon carbide (SiC) derived from agricultural

	waste potentially competitive with silicon anode," *Green Chemistry*, **2022**, ***24***, 4061– 4070. https://doi.org/10.1039/D2GC00645F 9. M. Yu, M. Wang, S. Indris, J.Manassa, A.Stangel, R.Hovden, R. M. Laine, "An Unexpected Source of Hard Carbon, Rice Hull Ash, Provides Unexpected Li^+ Storage Capacities," Advanced Sustainable Systems, **2024**, *2400667*. https://doi.org/10.1002/adsu.202400667
Additional information	**Learning outcomes.** **In terms of knowledge** - A person who has completed education at the Doctoral School of Adam Mickiewicz University knows and understands: E_W01; E_W02; E_W03; E_W06 **In terms of skills** - A person who has completed education at the Doctoral School of Adam Mickiewicz University is able to: E_U01; E_02; E_U05 **In terms of social competences** - A person who has completed education at the Doctoral School of Adam Mickiewicz University is prepared for: EK01; E_K05