

Andrzej Szczurek, PhD

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EDUCATION

2008 – 2011 PhD in Chemistry, University of Lorraine, Institut Jean Lamour – CNRS – UMR 7198

Thesis title: The new organic and carbon gels derived from natural and synthetic phenolic compounds.

(Funded by EGIDE bursary)

Supervisors: Alain Celzard, Prof; Antonio Pizzi, Prof, D.Sc.; Vanessa Fierro, PhD

Brief synopsis of research:

Organic and carbon gels are known as attractive highly porous materials combining a number of excellent and unique characteristics such as extreme lightweight, high surface area and adjustable mesoporosity. From such valuable features, organic and carbon gels may find various applications. For instance, organic gels have been suggested as sorbents, thermal insulator drug delivery materials. Besides, after pyrolysis, carbon gels can be used as high surface area adsorbents, catalysts or catalyst supports and as electrodes for double-layer capacitors. The major disadvantage of these gels is the high cost of the synthesis process. From one side the price of resorcinol, the most common precursor of gels, and from the other expensive supercritical drying in CO₂ are limiting the production of gels on a large scale. Thus, the goal of this work, conducted in two parallel ways, was developing and characterizing novel organic and carbon gels from natural precursors, such as condensed Tannin, as also applying new routes of drying in order to decrease synthesis costs.

2002 – 2007 Master of Science, engineer Wrocław University of Technology, Chemistry Department, specialty: Macromolecular Materials Engineering. Wrocław, Poland.

Grade: 4 (good)

Final Year Research Project: Chemically activated anthracites for gases storage.

The purpose of this work was the investigation of adsorptive properties of activated carbons. Adsorption measurements were conducted with several types of gases and vapours, such as N₂, CO₂, H₂, Benzene, and Dichloromethane. Part of this work was realized during my scholar internship in France. This work required methodical progress with regards to health and safety regulations and to pay close attention to detail in order to achieve accurate results.

Scientific supervisor honours: very good

1998 – 2002 Wladyslaw Jagiello's Secondary school, Zabkowice Slaskie, Poland.

A-levels: Polish, Biology, English, at grades 5 and 4

GCSE's: 15 including Mathematics, Chemistry, Physics and German, all at grades 5 to 4

EMPLOYMENT

2017 - Post – doctorate, University of Warsaw, Centre of New Technologies, Warsaw, Poland.

I'm a leader of the project: *BEACs: new allotropic forms of carbon. Synthesis, doping, and electronic and adsorption properties*. The project is realised in a framework of **Sonata Bis** funding scheme supported by National Science Centre.

2011 – 2015 Post – doctorate, University of Lorraine, Institut Jean Lamour – UMR – CNRS 7198, Epinal, France.

I worked as part of Professor A. Celzard's research group in the field of synthesis and characterization of novel organic and carbon materials based on natural precursors, such as Condensed Tannin. My work involved developing, optimizing and characterizing novel emulsion – templated porous materials, with excellent porous and mechanical properties.

2008 – 2011 PhD student, University of Lorraine, Institut Jean Lamour–UMR– CNRS 7198, Epinal, France.

Duties involved applying novel polyphenolic precursors and new drying routes in order to decrease synthesis costs of organic and carbon gels.

2008 Foreman's assistant, HSV Polska Sp.z.o.o, Wroclaw, Poland (9 months)

Duties involved operating machines (Erlenbach Maschinen) for expanded polystyrene (EPS) pre-expanding and molding, maintaining the fluidity of production and leading a 12-person crew.

SKILLS

Characterization techniques:

- Porous properties: Hg porosimetry, He pycnometry, Nitrogen and CO₂ adsorption.
- Chemical composition: Elemental analysis, FT-IR, Raman, GC-MS, Maldi-TOF,
- Physical properties: TG/DSC, TMA, Thermal conductivity,
- Mechanical properties: Compression, 3 point bending, tension tests
- Microscopy: SEM, TEM, Polarized light microscopy
- Electrochemistry: Cyclic Voltammetry, Galvanostatic Charge/Discharge, Electrochemical Impedance Spectroscopy.
- Rheology: Turbiscan and Rheolaser (both Formulaction), Brookfield's viscometer.
- Contact angle measurements
- X-ray tomography

Laboratory skills:

- Sol-gel synthesis
- Emulsification
- Hydrothermal synthesis
- Fibre Extruding
- Supercritical drying in different solvents (CO₂, Acetone, Ethanol, Methane)
- Supercritical doping of porous materials with metal nanoparticles

- Lyophilisation
- Pyrolysis and calcination
- Physical and chemical activation
- Filtration and extraction
- Soxhlet extraction
- Bar and spray coating
- Glove box manipulation

Time Management

It was important to complete my PhD within 3 years and this I did successfully. I met without fail all the deadlines. I worked on several projects in parallel. I have extensive experience of juggling different tasks and bringing these to a successful conclusion.

Teamwork

“Mr Andrzej SZCZUREK is known as a good colleague always ready to share recommendations and to help in the lab. He always gets along with everyone, is deeply involved in the many things he participates in, and has the ability to compromise with other team members. He is truly optimistic in any situation, always saying that there are no problems but only solutions. His great sense of humour is also quite useful to de-stress people during the activity peaks occurring very often in the lab.” - Prof Alain Celzard

I was invited to participate in many international projects:

- Synthesis of lignin-based carbon gels in collaboration with the University of Krasnoyarsk, Russia
- Hydrothermally-synthesized 3D periodic carbon structures in collaboration with The iCIMSI Research Institute – University of Applied Sciences (SUPSI), Department of Technology and Innovation, Manno, Switzerland (the corresponding paper was retained as cover page of one issue of the journal Carbon)
- Electrochemical characterization of hydrothermally-obtained carbons and phenol-derived carbon cryogels in collaboration with the University of Poznan
- Investigations of Li-ion batteries in collaboration with the University of Liege
- Electromagnetic properties of carbon foams in collaboration with the Belarussian State University of Minsk.

Communication and languages

- Oral communication skills expressed in presentations and in talking to the general public. Writing skills developed with reports, publications and thesis writing.
- All documents required by the doctoral school were written in French (annual reports, projects). However my thesis was written and defended in English.
- Languages

Polish:	native language
<u>English:</u>	Upper-intermediate (B2)
<u>French:</u>	intermediate (writing), intermediate (conversation)

Other skills

- Data and information collection
- Fluency in Microsoft Office packages, Windows from XP to 8, OriginLab, ImageJ, ImageProPlus, ACD/ChemSketch
- I have a fundamental knowledge of Autodesk’s Maya and AutoCad, SSPS,
- I have co-supervised 2 undergraduate research projects of final year students.

APPENDIX

Research statement

My experience with carbon materials began in 2005, when I was obligated to prepare a scientific project at the Wroclaw University of Technology. The project, under supervision of Dr Andrzej Albiniak, was focused on the investigation and optimisation of chemical activation of polish anthracites with KOH and NaOH. Anthracites were activated in different anthracite/activation agent ratios, and the effects of activation were investigated by adsorption measurements in various gases and vapours such as CO₂, N₂, H₂, Benzene and Dichloromethane, which presented different molecule sizes. The results have shown significant effects of the activation ratio on porous properties of activated carbons, whereas the optimal activation ratio of 4:1 was found. Part of this work was done in the framework of the Polish - French POLONIUM exchange program. In cooperation with Dr Vanessa Fierro from the University of Lorraine (former University Henri Poincaré), the H₂ storage of activated anthracites was analysed. Obtained results were a significant part of my MSc final rapport and were included also in one article published in the journal *Carbon*.

This fruitful cooperation with Dr Vanessa Fierro resulted in my PhD thesis starting in October 2008. The aim of my thesis directed by Alain Celzard, Prof Pizzi and Dr Vanessa Fierro was synthesizing, developing and characterizing novel organic and carbon gels based on cheap and bio resourced polyphenolic compounds, in this case condensed Mimosa tannin. And, in parallel, developing and optimising the alternative hydrogels' drying routes. Carbon gels, due to their excellent, versatile properties, are used in many applications in which high porosity, extremely low density, and high surface area and adjustable mesoporosity are desired. The synthesis of such materials is based on the sol-gel reaction of resorcinol with formaldehyde. The crosslinking reaction occurring during the polycondensation leads to a macromolecule with pores filled with solvent. The evacuation of the solvent via supercritical drying in CO₂ results in extremely porous lightweight materials with a high surface area. The main drawback limiting industrial usage of these materials is the high costs of synthesis including expensive reactants and drying methods. My investigations have shown that Tannin is an excellent replacement of Resorcinol in gel production and the unlimited variations of synthesis conditions, such as concentrations of precursors, pH of solution, crosslinking degree, make their properties fully controllable. Moreover, it was shown that drying in supercritical acetone or ethanol, is less costly, and can easily compete with drying in supercritical CO₂. In parallel, I was able to do some fundamental work on adhesives, postulating that all cold-set adhesives would lead to highly porous polymer gels after doing some relevant modifications of the formulations.

After successfully completing my PhD thesis, I was asked to continue the work in Prof Celzard's lab first for 2 years, but at the end I have now spent four years. During this time I was involved in many different projects concerning carbon gels, glassy carbons, carbon foams and also production of fibres via Tannin resin-POE composite extruding. In my most significant project, I developed and patented emulsion-templated monoliths from bio resourced compounds such as Tannin, Furfuryl alcohol and vegetable oil. These new tannin based materials were characterized by well-developed open-cell structure with very good thermal properties and outstanding mechanical resistance. In the same patent the new kinds of carbon foams were also included, the mechanical biting of tannin solution as porosity forcing method was presented for the first time. In parallel, The Icotex project, on which I worked, involved producing a flax fibre-foam composite for thermal insulation. I was responsible for mechanical and thermal investigation of those composites. The results have shown that such composites could be successfully used as insulators with proper mechanical resistance; however the process of implementation of the product into moulds was not well designed for such kind of materials. In last year I have worked on 3D printed carbon cellular lattices, (the corresponding paper was retained as the cover page of one issue of the journal *Carbon*). The 3D printed polymeric lattices were hydrothermally impregnated with Resorcinol – Formaldehyde resin, whereas the polymeric skeleton was then removed during slow pyrolysis resulting in homogeneous carbon lattices. These seven years I've completed 1 patent, over 30 articles published in A-level international peer-reviewed journals, 1 national peer-reviewed journal and more than 30 communications.

To summarize, at this point in my career, my primary interests are in the continuation of research in the field of carbon materials and to go further with laboratory research in carbon materials for numerous applications including adsorption or energy storage.

In the long term I see myself working as an independent scientist at a university position, or as an associate professor, in the field of carbon materials.

Fellowships, Grants and Awards

2017 – 2021	Sonata Bis grant supported by National Science Centre.
2008 – 2011	PhD thesis funded by an EGIDE bursary: University of Lorraine, ENSTIB Epinal, France
2007.10 – 2007.12:	Grant from the French embassy in Poland: Université Henri Poincaré Nancy 1 (now University of Lorraine), Vandœuvre-lès-Nancy, France
2007.06:	Grant from the POLLONIUM Polish – French exchange program: Université Henri Poincaré Nancy 1 (now University of Lorraine), Vandœuvre-lès-Nancy, France
2006.07:	Grant from the POLLONIUM Polish–French exchange program: Université Henri Poincaré Nancy 1 (now University of Lorraine), Vandœuvre-lès-Nancy, France.