



Prof. dr. hab. Halina Abramczyk

Curriculum Vitae

Education

Dr. Sc. Habilitation (Chemistry, Molecular spectroscopy), Lodz University of Technology, Poland
Post doctoral fellowship, Bielefeld University, Germany
Ph. D. (Chemistry), Lodz University of Technology, Poland
M. Sc. (Physics, First Class Honors), University of Lodz, Poland

Career /Employment

1999-present	Full professor, Lodz University of Technology, Poland
2009-/2010	Visiting professor, University of Nairobi, Kenya
2007-2009	Full professor, Marie Curie Chair, Max Born Institute, Berlin, Germany
2002-2003	Visiting professor, University of Arizona, Tucson, USA
1998	Visiting professor, M.-Luther Univ., Halle, Germany
1989-1993	Associate Professor, Lodz University of Technology, Poland
1982-1989	Assistant Professor, Lodz University of Technology, Poland

Professional Qualifications:

- Molecular spectroscopy, physical chemistry, biospectroscopy, molecular imaging, laser spectroscopy, medical diagnostics of cancer
- experience in Raman, IR spectrometry, Raman imaging, IR imaging , AFM imaging, SERS, SNOM imaging and fluorescence spectroscopy
- experience in titanium-sapphire femtosecond oscillator, regenerative amplifier, optical parametric amplifier technologies, and femtosecond laser pulse diagnostic devices
- experience in chemometric analysis (cluster analysis, PCA Vertex Component Analysis (VCA), Hierarchical Cluster Analysis (HCA)) and algorithms for optimization spectroscopic data.
- experience in picosecond resonance CARS (PR/CARS) and picosecond time-resolved CARS (PTR/CARS) with the second harmonic output of a cw, mode-locked Nd:YAG laser and dye lasers.


Research Accomplishments: <https://www.mitr.p.lodz.pl/raman>

Our group is exploring and pushing the frontiers of vibrational spectroscopy, and ultrafast laser spectroscopy in medical applications, with particular emphasize on cancer diagnostics. We are using Raman microscopy, AFM, SNOM microscopy, femtosecond pump-probe methods, Raman imaging. My group initiated transfer of Raman imaging and ultrafast laser technology to medical diagnostics of human cancers that can be useful in clinical in vivo applications. Our group has established links and collaboration with Medical University of Lodz and many hospitals as well as Universities all around the world such as Cambridge University, Osaka University, Japan, Max Born Institute, Berlin, University

of Bordeaux, France. We pioneered the ‘optical biopsy’ of normal and cancerous human tissues of breast, brain, head and neck, and digestive tract by Raman imaging. We have been conducting research on metabolic reprogramming of lipids in cancer cells. We examine the chemical composition and spectroscopic determinants of the biochemical status of lipid droplets depending on the degree of aggressiveness. We proposed a method of monitoring epigenetic changes (acetylation and methylation) in neoplastic diseases as well as a method of monitoring the epithelial cell polarity in the mammary duct of the mammary gland. Abramczyk and colleagues showed that using combined Raman, AFM, SNOM imaging methods for biochemical, mechanical, topographic mapping of human tissues and cells of the brain, breast, head and neck cancer reveal the characteristic features of molecular vibration, mechanical stiffness and adhesion parameters that distinguish normal cells from cancer and monitor the cancer phenotype as well as epigenetic changes accompanying the development of cancer. We demonstrated a key role of vibronic coupling for solvated electron, H-bonded systems, and biologically important proteins. Our research interest includes also mechanism of femtosecond dynamics of the primary events in the bacteriorhodopsin photocycle, photochemistry and femtosecond dynamics of the primary events in phthalocyanine metal complexes, correlations between molecular mechanisms of vibrational relaxation and phase transitions in liquids, supercooled liquids, glasses, crystals.

HOW DOES RAMAN SPECTROSCOPY AND IMAGING BENEFIT CANCER RESEARCH?

•RAMAN OPTICAL BIOPSY





The completeness of the surgical resection is a key factor in the progress of patients with cancers. The safety margin can be positive which means that not all cancer cells have been removed in the surgery. Patients with a positive margin often require some surgery to make sure that all the cancer is removed. The advantage of the "Raman biopsy" is that it provides direct biochemical information (vibrational fingerprint) in real time, it is not prone to subjective interpretation, and it monitors biological tissue without any external agents, in contrast to histopathological assessment.

N. Abramczyk, B. Brozek-Piaska, J. Sarmacki, J. Jablonska-Galewicz, R. Kordek, PMSB 198 (2012) 74-81


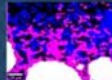
HOW DOES RAMAN SPECTROSCOPY AND IMAGING BENEFIT CANCER RESEARCH?

•RAMAN BIOMARKERS OF CANCER

Sarmacki J, Brozek-Piaska B, Kordek R, Abramczyk N. The lipid reactive oxygen species phenotype of breast cancer. Raman spectroscopy and mapping, PCR and PLGA for accurate detection of cancer and breast tumor recurrence. Molecular biomarkers: mechanisms beyond Warburg effect. Analyst. 2015; 140, 2211 - 2215, (DOI=10.1039/C5AN01847G)

VIRTUAL RAMAN HISTOPATHOLOGY IMAGE





Abramczyk N et al., patent application

STANDARD H&E HISTOPATHOLOGY RAMAN HISTOPATHOLOGY IMAGE

- Fast histopathological analysis for clinical practice
- Label-free histopathological analysis (without any staining procedures)
- Real time diagnostics to access the safety margin during operation by Raman-guided surgery
- High spatial resolution (small cancer changes can be easily identified)
- Objective diagnosis (without human interpretation, Raman spectra)
- Discrimination of grades with high specificity and sensitivity (c.a. 90%)
- Monitoring of tumor tissue heterogeneity

RAMAN SPECTROSCOPY GUIDES IN VIVO BRAIN OPTICAL BIOPSIES



International Collaboration

- University of Cambridge - Cavendish Laboratory, UK, prof. Sarah E Bohndiek.
- Advanced Ultrafast Laser Research Center, Takayoshi Kobayashi Lab, Osaka University, Department of Chemistry, Graduate School of Engineering, Japan, University of Electro-Communications, Advanced Ultrafast Laser Research Center, Japan, prof. Takayoshi Kobayashi.
- coordinator of the Polish-American Joint project between the Polish Ministry of Education and National Science Foundation (2002, MEN- NSF).
- EU funding (2007-2009, Marie Curie Excellence Chair).
- Research collaboration with Medical University of Lodz.
- University of Bordeaux, Laboratoire Ondes et Matière d'aquitaine (LOMA), prof. E. Freysz
- WITec GmbH, dr Jan Toporski, dr E. Bailo, dr Th Dieing.

- University of Arizona, USA, University of Florida, Colorado State University, prof G. Atkinson, prof. B. Ladanyi.
 - Fulbright Fellowship, visiting professor, University of Arizona, Tucson, USA.
 - Laboratoire d'Optique Appliquee, CNRS, INSERM, Ecole Polytechnique - Ecole Nationale Supérieure De Techniques Avancées, Palaiseau, France, prof. Y. A. Gauduel.
 - Collaboration within European Virtual University on Lasers (<http://www.mitr.p.lodz.pl/evu/wyklady/>) has been established with: prof. R. Trebino, Georgia Institute of Technology, USA, prof. E. Vauthey, University of Geneva, Switzerland, prof. A. Materny, Jacobs University Bremen, Germany, prof. G. Fleming, University of California, Lawrence Berkeley National Laboratory, USA, dr. G. Filippidis, Institute of Electronic Structure and Laser, Greece, prof. M. Diem, Northeastern University, USA, prof. P. Hamm, University of Zurich, Switzerland, dr. G. Steinmeyer, Max-Born-Institut, Berlin, Germany, prof. S. Mukamel, University of California, USA.
- **RESEARCH PUBLICATIONS**

h-index=32, total number of citation=2869

1. M. Kopec, K. Beton-Mysur, H. Abramczyk, Biochemical changes in lipid and protein metabolism caused by mannose-Raman spectroscopy studies, *Analyst*, **2024**, DOI: 10.1039/D4AN00128A,
2. M. Kopec, A. Borek-Doros, K. Jarczewska, M. Baranska, H. Abramczyk, Role of cardiolipin and cytochrome c in mitochondrial metabolism of cancer cells by Raman imaging: in vitro study on brain glioblastoma U-87 MG cell line, *Analyst*, **2024**, DOI: 10.1039/d4an00015c,
3. M. Kopec, K. Beton-Mysur, The role of glucose and fructose on lipid droplet metabolism in human normal bronchial and cancer lung cells by Raman spectroscopy, *Chemistry and Physics of Lipids*, **2024**, 259, 105375
4. J. M. Surmacki, H. Abramczyk, Confocal Raman imaging reveals the impact of retinoids on human breast cancer via monitoring the redox status of cytochrome, *Scientific Reports*, **2023**, 13(1), 15049
5. H. Abramczyk, J. Surmacki, Effect of COVID-19 mRNA Vaccine on Human Lung Carcinoma Cells In Vitro by Means of Raman Spectroscopy and Imaging, *ACS Omega*, **2023**, 8(45), 42555-42564, DOI:10.1021/acsomega.3c05287
6. C. Agodi¹, F. Cappuzzello, G. Cardella, G. A. P. Cirrone, E. De Filippo, A. Di Pietro¹, A. Gargano, M. La Cognata, D. Mascali, G. Milluzzo, R. Nania, G. Petringa, A. Pidotella, S. Pirrone, R. G. Pizzone, G. G. Rapisarda, M. L. Sergi, S. Tudisco, J. J. Valiente-Dobón, E. Vardaci, H. Abramczyk, L. Acosta, P. Adsley, S. Amaducci, T. Banerjee, D. Batani, J. Bellone, C. Bertulani, S. Biri, A. Bogachev, A. Bonanno, A. Bonasera, C. Borcea, M. Borghesi, S. Bortolussi, D. Boscolo, G. A. Brischetto, S. Burrello, M. Busso, S. Calabrese¹, S. Calinescu, D. Calvo, V. Capirossi, D. Carbone, A. Cardinali, G. Casini, R. Catalano, M. Cavallaro, S. Ceccuzzi, L. Celona, S. Cherubini, A. Chieffi, I. Ciraldo, G. Ciullo, M. Colonna, L. Cosentino, G. Cuttone, G. D'Agata, G. De Gregorio, S. Degl'Innocenti, F. Delaunay, L. Di Donato, A. Di Nitto, T. Dickel, D. Doria, J. E. Ducret, M. Durante, J. Esposito, F. Farrokhi¹, J. P. Fernandez Garcia, P. Figueral, M. Fisichella¹, Z. Fulop, A. Galatá, D. Galaviz Redondo, D. Gambacurta, S. Gammino, E. Geraci³, L. Gizzi, B. Gnoffo, F. Groppi, G. L. Guardo¹, M. Guarrera¹, S. Hayakawa, F. Horst, S. Q. Hou, A. Jarota, J. José, S. Karl, A. Karpov, H. Kierzkowska-Pawlak, G. G. Kiss, G. Knyazheva, H. Koivisto, B. Koop, E. Kozulin, D. Kumar, A. Kurmanova¹, G. La Rana, L. Labate, L. Lamia, E. G. Lanza, J. A. Lay, D. Lattuada, H. Lenske, M. Limongi, M. Lipoglavsek, I. Lombardo, A. Mairani, S. Manetti, M. Marafini, L. Marcucci, D. Margarone, N. S. Martorana¹, L. Maunoury, G. S. Mauro¹, M. Mazzaglia¹,

- S. Mein, A. Mengoni, M. Milin, B. Mishra¹, L. Mou, J. Mrazek, P. Nadtochy, E. Naselli¹, P. Nicolai, K. Novikov, A. A. Oliva¹, A. Pagano, E. V. Pagano¹, S. Palmerini, M. Papa, K. Parodi, V. Patera, J. Pllumaj, C. Petrone, S. Piantelli, D. Pierroutsakou, F. Pinna, G. Politi, I. Postuma, P. Prajapati¹, P. G. Prada Moroni, G. Pupillo, D. Raffestin¹, R. Rac¹, C.-A. Reidel, D. Rifuggiato¹, F. Risitano, F. Rizzo, X. Roca Maza, S. Romano, L. Roso, F. Rotaru, A. D. Russo¹, P. Russotto¹, V. Saiko, D. Santonocito¹, E. Santopinto, G. Sarri, D. Sartirana, C. Schuy, O. Sgouros¹, S. Simonucci, G. Sorbello¹, V. Soukeras¹, R. Sparta¹, A. Spatafora, M. Stanoiu, S. Taioli, T. Tessonier, P. Thirolf, E. Tognelli, D. Torresi¹, G. Torrisi¹, L. Trache, G. Traini, M. Trimarchi, S. Tsikata, A. Tumino, J. Tyczkowski, H. Yamaguchi, V. Vercesi¹, I. Vidana, L. Volpe and U. Weber, Nuclear physics midterm plan at LNS, *European Physical Journal Plus*, **2023**, 138(11), 1038, DOI: 10.1140/epjp/s13360-023-04358-7
7. H. Abramczyk, J.M. Surmacki, Control of Mitochondrial Electron Transport Chain Flux and Apoptosis by Retinoic Acid: Raman Imaging In Vitro Human Bronchial and Lung Cancerous Cells, *Cancers*, **2023**, 15(18), 4535, DOI: 10.3390/cancers15184535
 8. M. Kopec, K. Beton-Mysur, H. Abramczyk, Raman imaging and chemometric methods in human normal bronchial and cancer lung cells: Raman biomarkers of lipid reprogramming, *Chemistry and Physics of Lipids*, **2023**, 257, 105339
 9. H. Abramczyk, J.M. Surmacki, M. Kopec, K. Jarczewska, B. Romanowska-Pietrasiak, Hemoglobin and cytochrome c. reinterpreting the origins of oxygenation and oxidation in erythrocytes and in vivo cancer lung cells, *Scientific Reports*, **2023**, 13, 14731,
 10. M. Kopec, K. Beton, K. Jarczewska, H. Abramczyk, *Hyperglycemia and cancer in human lung carcinoma by means of Raman spectroscopy and imaging*, *Scientific Reports*, **2022**, 12(1), 18561
 11. H. Abramczyk, B. Sobkiewicz, R. Walczak-Jedrzejowska, K. Marchlewska, J. Surmacki, *Decoding the role of cytochrome c in metabolism of human spermatozoa by Raman imaging*, *Frontiers in Cell and Developmental Biology*, **2022**, 10, 983993
 12. M. Kopec, B. Romanowska-Pietrasiak, H. Abramczyk, *Decoding Breast Cancer Metabolism: Hunting BRCA Mutations by Raman Spectroscopy*, *Photochem*, **2022**, 2(3), 752-764, <https://doi.org/10.3390/photochem2030048>
 13. M. Kopec, H. Abramczyk, *Analysis of eggs depending on hens breeding systems by Raman spectroscopy*, *Food Control*, 141, **2022**, 109178
 14. H. Abramczyk, B. Brozek-Pluska, M. Kopec, *Double face of cytochrome c in cancers by Raman imaging*, *Scientific Reports*, 12, **2022**, 2120, DOI: 10.1038/s41598-022-04803-0
 15. H. Abramczyk, J. M. Surmacki, B. Brozek-Pluska, *Redox state changes of mitochondrial cytochromes in brain and breast cancers by Raman spectroscopy and imaging*, *Journal of Molecular Structure*, **2022**, 132134, DOI:10.1016/j.molstruc.2021.132134
 16. M. Kopec, H. Abramczyk, *The role of pro- and antiangiogenic factors in angiogenesis process by Raman spectroscopy*, *Spectrochimica Acta - Part A: Molecular and Biomolecular Spectroscopy*, 268, **2022**, 120667, DOI: 10.1016/j.saa.2021.120667
 17. Kopec, M. Błaszczyk, M. Radek, H. Abramczyk, *Raman imaging and statistical methods for analysis various type of human brain tumors and breast cancers*, *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, **2021**, 120091, <https://doi.org/10.1016/j.saa.2021.120091>.
 18. H. Abramczyk, J.M. Surmacki, B. Brozek-Pluska, M. Kopec. *Revision of Commonly Accepted Warburg Mechanism of Cancer Development: Redox-Sensitive Mitochondrial Cytochromes in Breast and Brain Cancers by Raman Imaging*. *Cancers*. **2021**; 13(11):2599. <https://doi.org/10.3390/cancers13112599>

19. H. Abramczyk, A. Imiela, J. Surmacki, *Novel strategies of Raman imaging for monitoring intracellular retinoid metabolism in cancer cells*, Journal of Molecular Liquids, **2021**, 116033, <https://doi.org/10.1016/j.molliq.2021.116033>
20. H. Abramczyk, B. Brozek-Pluska, M. Kopec, M. Blaszczyk, M. Radek, *Redox Imbalance and Biochemical Changes in Cancer by probing redox-sensitive mitochondrial cytochromes in label-free visible resonance Raman imaging*, Cancers **2021**, 13(5):960. doi: 10.3390/cancers13050960A.
21. A. Jarota, E. Pastorczak, H. Abramczyk, *A deeper look into the photocycloreversion of a yellow diarylethene photoswitch: Why is it so fast?*, Physical Chemistry Chemical Physics, **2020**, 22(10), 5408-5412.
22. B. Brozek-Pluska, A. Jarota, R. Kania, H. Abramczyk, *Zinc Phthalocyanine Photochemistry by Raman Imaging, Fluorescence Spectroscopy and Femtosecond Spectroscopy in Normal and Cancerous Human Colon Tissues and Single Cells*, Molecules (Basel, Switzerland), **2020**, 25(11).
23. A. Imiela, J. Surmacki, H. Abramczyk, *Novel strategies of Raman imaging for monitoring the therapeutic benefit of temozolomide in glioblastoma*, Journal of Molecular Structure, **2020**, 1217, 12838.
24. H. Abramczyk, B. Brozek-Pluska, A. Jarota, J. Surmacki, A. Imiela, M. Kopec, *A look into the use of Raman spectroscopy for brain and breast cancer diagnostics: linear and non-linear optics in cancer research as a gateway to tumor cell identity*, Expert Review of Molecular Diagnostics, **2020**, 20, 99-115,
25. B. Brozek-Pluska, A. Dziki, H. Abramczyk, *Virtual spectral histopathology of colon cancer - biomedical applications of Raman spectroscopy and imaging*, J. Mol. Liq, **2020**, 303, 112676,
26. H. Kierzkowska-Pawlak, J. Tyczkowski, A. Jarota, H. Abramczyk, *Hydrogen production in liquid water by femtosecond laser-induced plasma*, Applied Energy, **2019**, 247, 21-34.
27. B. Brozek-Pluska, J. Musial, R. Kordek, H. Abramczyk, *Analysis of Human Colon by Raman Spectroscopy and Imaging-Elucidation of Biochemical Changes in Carcinogenesis*, International Journal of Molecular Sciences, **2019**, 20(14), 3398.
28. E. Świdarska, M. Podolska, J. Strycharz, M. Szwed, H. Abramczyk, B. Brożek-Pluska, A. Wróblewski, J. Szemraj, I. Majsterek, J. Drzewoski, A. Śliwińska, *Hyperglycemia Changes Expression of Key Adipogenesis Markers (C/EBP α and PPAR γ) and Morphology of Differentiating Human Visceral Adipocytes*, Nutrients, **2019**, 2019, 11, 1835.
29. H. Abramczyk, A. Imiela, B. Brozek-Pluska, M. Kopec, *Advances in Raman imaging combined with AFM and fluorescence microscopy are beneficial for oncology and cancer research*, Nanomedicine-Future Medicine, **2019**, 14(14), 1873–1888.
30. M. Kopec, A. Imiela, H. Abramczyk, *Monitoring glycosylation metabolism in brain and breast cancer by Raman imaging*, Scientific Reports, **2019**, 9, 166.
31. H. Abramczyk, A. Imiela, A. Śliwińska, *Novel strategies of Raman imaging for exploring cancer lipid reprogramming*, Journal of Molecular Liquids, 274, **2019**, 52-592.
32. A. Jarota, E. Pastorczak, W. Tawfik, B. Xue, R. Kania, H. Abramczyk, T. Kobayashi, *Exploring the ultrafast dynamics of a diarylethene derivative using sub-10 fs laser pulses*, Phys. Chem. Chem. Phys., **2019**, 21, 192-204.
33. H. Abramczyk, B. Brozek-Pluska, M. Kopec, *Polarized Raman microscopy imaging: Capabilities and challenges for cancer research*, Journal of Molecular Liquids, 259, 102-111, **2018**.
34. M. Kopec, H. Abramczyk, *Angiogenesis - a crucial step in breast cancer growth, progression and dissemination by Raman imaging*, Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 198, 338-345, **2018**.
35. H. Abramczyk, A. Imiela, *The biochemical, nanomechanical and chemometric signatures of brain cancer*, Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 188, 8-19, **2018**.
36. H. Abramczyk, M. Kopec, *Applications of Raman scattering in biomedicine, telecommunication and thermography*, Measurement Automation Monitoring, 63, 38-40, **2017**.

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42. H. Abramczyk, J. Surmacki, M. Kopeć, A.K. Olejnik, A. Kaufman-Szymczyk, K. Fabianowska-Majewska, *Epigenetic changes in cancer by Raman imaging, fluorescence imaging, AFM and scanning near-field optical (SNOM). Acetylation in normal and human cancer breast cells MCF10A, MCF7 and MDA-MB-231*, *Analyst*, **2016**, 141(19), 5646-5658.
43. H. Abramczyk, B. Brozek-Pluska, *New look inside human breast ducts with Raman imaging. Raman candidates as diagnostic markers for breast cancer prognosis: mammaglobin, palmitic acid and sphingomyelin*, *Analytica Chimica Acta*, **2016**, 909, 91-100.
44. H. Abramczyk, J. Surmacki, M. Kopeć, A. K. Olejnik, K. Lubecka-Pietruszewska, K. Fabianowska-Majewska, *The role of lipid droplets and adipocytes in cancer. Raman imaging of cell cultures: MCF10A, MCF7, and MDA-MB-231 compared to adipocytes in cancerous human breast tissue*, *Analyst*, **2015**, 140(7), 2224-2235.
45. B. Brozek-Pluska, M. Kopeć, J. Surmacki, H. Abramczyk, *Raman microspectroscopy of the noncancerous and the cancerous human breast tissues. Identification and phase transitions of linoleic and oleic acids by Raman spectroscopy and Raman low-temperature studies*, *Analyst*, **2015**, 140(7), 2134-2143.
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• **INVITED, PLENARY AND KEY-NOTE LECTURES**

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 29. H. Abramczyk, Advances in ultrafast spectroscopies refine our understanding of quantum coherences, role of weak interactions and structural dynamics of biological systems: lipid membranes, bacteriorhodopsin, and breast cancer tissue, Central European School of Physical Organic Chemistry, 2-6 June 2009 Wrocław-Przesieka, Poland, **keynote lecture**
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