

# Abraham Kwame Badu-Tawiah

## Curriculum Vitae

Department of Chemistry and Biochemistry  
The Ohio State University  
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### EDUCATION

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| PhD<br>Chemistry            | <b>Purdue University</b> , West Lafayette, IN<br>Department of Chemistry<br><i>Thesis:</i> Ion Generation, Ion Collection and Ionic Reactions outside the Mass Spectrometer<br><i>Advisor:</i> Prof. R. Graham Cooks   | <b>August 2012</b> |
| MS<br>Chemistry             | <b>Indiana University of Pennsylvania (IUP)</b> , Indiana, PA<br>Department of Chemistry<br><i>Thesis:</i> Adsorption Isotherms of Diamond-Packed Columns in Reverse-Phase Liquid Chromatography<br><i>Advisor:</i> Dr. John Ford  | <b>May 2007</b>    |
| MSc<br>Organic<br>Chemistry | <b>Kwame Nkrumah University of Science and Technology</b> , Kumasi, Ghana<br>Department of Chemistry<br><i>Thesis:</i> Characterization, Hypoglycemic effects and Antioxidant Properties of the Chemical Constituents of <i>Portulaca Oleracea Linn</i><br><i>Advisors:</i> Dr. Sylvester K. Twumasi (Chemistry) and Prof. Eric Woode (Pharmacology) | <b>June 2005</b>   |
| BSc<br>Chemistry            | <b>Kwame Nkrumah University of Science and Technology</b> , Kumasi, Ghana<br>Department of Chemistry<br><i>Thesis:</i> Bleaching of Palm Kernel and Soybean Oils using Locally Prepared Clays from Ashanti Region, Ghana<br><i>Advisor:</i> Dr. Johannes A. M. Awudza  | <b>June 2002</b>   |

### PROFESSIONAL EXPERIENCE

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|------------------------|---|--------------------------------|
| Assistant<br>Professor | <b>The Ohio State University</b> , Columbus, OH<br>Department of Chemistry and Biochemistry   | <b>July 2012 – Present</b>     |
| Postdoctoral<br>Fellow | <b>Harvard University</b> , Cambridge, MA<br>Department of Chemistry Chemical Biology<br><i>Advisor:</i> Prof. George M. Whitesides | <b>August 2012 – June 2014</b> |

### CURRENT RESEARCH EXPERIENCE

**Harvard University**, Cambridge, MA **2012 – present**

#### 1. Functionalized-Paper for Water Harvesting and Purification

Developed a greener and low-cost method for cleaning of large scale deepwater oil spills. The method takes advantage of cellulose materials such as cotton fabric and paper, which are abundant and readily available at low cost, and can be burnt after use with no environmental concerns

## 2. Low-cost Paper-based Disease Diagnosis

### *Time-independent Paper-based Malaria Diagnosis*

Led the development of new methods that combine functionalized-paper and polymerization-based amplification for immunoassay testing. The new approach decouples analyte capture from signal amplification; in this case, the signal amplification is time-independent, and occurs only in the presence of an applied light. We have used this technology for nucleic acid detection, malaria diagnosis and the detection antibodies specific to *Brucella abortus*, for Brucellosis diagnosis

### *Vertical-flow Immunoassay Device for Diagnosis of HIV and Syphilis Infection*

Team-developing a three-dimensional immunoassay paper-based device for multiplexed detection of HIV and syphilis in blood

## 3. Protein Biophysics

Protein/ligand binding and hydrophobic effects: volume vs. surface area of ligands. We have observed that there is entropy/enthalpy compensation for the overall free energy associated with the binding of *p*-substituted benzene sulfonamide ligands to human carbonic anhydrase II only when there substantial change in ligands volume but not its surface area.

## PREVIOUS RESEARCH EXPERIENCE

Purdue University, West Lafayette, IN

2007 – 2012

### 1. Instrumentation

*Ambient Ion Soft Landing Apparatus* – for ion purification, focusing and collection in the open lab environment

*Contained-Electrospray Apparatus* – for on-line derivatization of analytes during electrospray ionization

*Nanospray Emitter Arrays* – enables large ion currents to be used for rapid and quantitative peptide cross-linking

### 2. Organic Reaction using Molecular Ions

This is a new area of ionic chemistry made possible through my work at Purdue. Molecular ions are considered as ordinary organic molecules, and they are generated, transmitted and reacted with vapors or adsorbates on surfaces, all in the ordinary open environment

### 3. Droplet Accelerated Reactions outside the Mass Spectrometer

Charged microdroplets are used for synthesis of chemical compounds. The droplet environment (i.e. the confined microreactor volume) increases the speed of chemical synthesis.

### 4. Fundamental Ion Chemistry and Mechanistic Studies

Both solvent-free and micro-solvated reaction conditions offer unique opportunities to study reaction pathways that are not readily accessible under the traditional bulk solution-phase reaction conditions

### 5. Ambient Ionization Mass Spectrometry

#### *Desorption Electrospray Ionization (DESI)*

Developed two solvent optimization procedures for DESI: (i) based on octanol-water partitioning ( $K_{ow}$ ) value of analyte, and (ii) surfactant spray solution for enhanced analyte dissolution and ion desolvation

#### *Paper Spray Ionization*

Developed ambient ionization mass spectrometric method for *in-situ* analysis of corrosion inhibitor residues in crude oil using paper spray ionization and a portable mass spectrometer

#### *Desorption Atmospheric Pressure Chemical Ionization (DAPCI)*

Modified DAPCI ion source to enable mass spectrometric analysis of hydrocarbons via charge exchange reactions under ambient conditions

**Indiana University of Pennsylvania, Indiana, PA** **2005 – 2007**

**Separation Science and Surface Characterization**

Studied the adsorption of small organic molecules onto diamond surface using high performance liquid chromatography (HPLC) and generated data that were fitted to different isotherm models

Investigated the possibility of using diamond packed columns as a stationary phase in reverse phase (RP)-HPLC and recommended efficient ways of packing diamond particles into a column

**Kwame Nkrumah University of Science and Technology, Kumasi, Ghana** **2003 – 2005**

**Bioactivity-Guided Phytochemical Fractionation**

Characterized and investigated the hypoglycemic effects and antioxidant properties of the chemical constituents of *Portulaca Oleracea Linn*. Results showed that the local plant possess some hyperglycemic effect, although not as effective as glibenclamide, an anti-diabetic drug

Bioactivity-guided fractionation of extracts through bulk transfer was conducted to aid in elucidating the physico-chemical properties of the active constituents of the plant

**TEACHING/MENTORING EXPERIENCE**

**Harvard University, Department of Chemistry and Chemical Biology**

**Mentoring and Collaborations**

**2012 – present**

Mentored two undergraduates: *Danny Cramer* (Harvard University, summer 2013), and *Raphael Dreier* (visiting student, University of Applied Sciences Northwestern, Switzerland, summer 2013)

Collaborated with the Sikes' research group, Department of Chemical Engineering, Massachusetts Institute of Technology, for the implementation of polymerization-based amplification on paper for malaria detection

**Purdue University, Department of Chemistry**

**1. Volunteer Instructor**

**2008 – 2009**

*Particle Spectroscopy – advanced mass spectrometry course for graduate students*

*Advanced Instrumental Analysis – undergraduate senior level class*

Gave some lectures in the absence of the Professor, had some influence on exam content, run labs, prepared solutions to all exams, tests, home works and graded all problem sets, papers and exams

**2. Teaching Assistant**

**2007 – 2009**

*Required general chemistry for freshman engineering (CHM 115) and non-science students (CHM 111/112)*

Independently supervised lab sections, and organized office hours and recitations. Graded problem sets, labs and exams

**3. Mentoring and Collaborations**

**2010 – 2012**

Organized Saturday class sections for interested students on advanced instrumental analysis and particles spectroscopy

Mentored several graduate students including two visiting student: *Celine Bland* (CPE Lyon, France), and *Fred Jjunju* (King Abdullah University of Science and Technology, Saudi Arabia)

Collaborated with two visiting professors by introducing them into the new area of ionic reactions outside the mass spectrometer: *Thomas Muller* (University of Innsbruck, Austria) and *Rodinei Augusti* (Federal University of Minas Gerais, Brazil)

**Indiana University of Pennsylvania, Department of Chemistry**

**Graduate Assistantship**

**2005 – 2007**

Prepared materials for general chemistry laboratory courses and demonstration

Assisted in laboratory and classroom work, and supervised educationally related operations

**1. Graduate Demonstration**

2003 – 2005

Teaching, grading, and supervision of undergraduate lab experiments

**2. National Service Personnel**

2003

Teaching, grading, and supervision of undergraduate lab experiments

**FELLOWSHIPS, GRANTS AND RECOGNITIONS**

- 1. Lilly Innovative Fellowship Award**, Purdue University **2012**  
Competitive award based on written proposal and on-site interview
- 2. Bisland Dissertation Fellowship**, Purdue University **2011**  
Competitive fellowship offered by the Purdue graduate school based on research achievements
- 3. NSF Stimulus Award**, Purdue University **2008 - 2012**  
Led the application, and managed all reports of Obama stimulus award offered by the National Science Foundation
- 4. Andrews Fellowship**, Purdue University **2007- 2009**  
Competitive 2-year fellowship presented to two first-year chemistry graduate students
- 5. Cumulative Exam Record**, Purdue University **2007**  
First and the only chemistry graduate student to pass four cumulative exams in just one sitting; this led to the Andrews Fellowship award
- 6. Academic Achievement Award**, IUP **2006**  
Competitive annual award for outstanding graduate students at Indiana University of Pennsylvania

**MEMBERSHIP**

1. American Chemical Society
2. American Society for Mass Spectrometry
3. National Organization for the Professional Advancement

**PUBLICATIONS**

PEER-REVIEWED GRADUATE RESEARCH: PURDUE UNIVERSITY

- 1. Badu-Tawiah, A.K.;** Bland, C.; Campbell, I.D.; Cooks, R.G. "Non-Aqueous Spray Solvents and Solubility Effects in Desorption Electrospray Ionization" *J. Am. Soc. Mass Spectrom.* **2010**, 21, 572-579
- 2. Badu-Tawiah, A.K.** and Cooks, R.G. "Enhanced Ion Signals in Desorption Electrospray Ionization using Surfactant Spray Solutions" *J. Am. Soc. Mass Spectrom.* **2010**, 21, 1423-1431
- 3. Espy, R.;** **Badu-Tawiah, A.K.;** Cooks, R.G. "Molecular Ions at Ambient Surfaces: Surface analysis and modification" *Current Opinion in Chemical Biology*, **2011**, 15, 1-7
- 4. Badu-Tawiah, A.K.;** Wu, C.; Cooks, R.G. "Ambient Ion Soft Landing" *Anal. Chem.* **2011**, 83 (7), 2648-2654
- 5. Badu-Tawiah, A. K.;** Cyriac J.; Cooks, R.G. "Reactions of Organic Ions at Ambient Surface in a Solvent-Free Environment" *J. Am. Soc. Mass Spectrom.* **2012**, 23,842-849
- 6. Badu-Tawiah, A.K.;** Campbell, I.D.; Cooks, R.G. "Reactions of Micro-Solvated Organic Compounds at Ambient Surface: Droplet Velocity, Charge State and Solvent Effects" *J. Am. Soc. Mass Spectrom.* **2012**, 23,1077-1084
- 7. Badu-Tawiah, A.K.;** Campbell, I.D.; Cooks, R.G. "Accelerated C-N Bond Formation in Dropcast Thin Films on Ambient Surfaces" *J. Am. Soc. Mass Spectrom.* **2012**, 23,1461-1468
- 8. Badu-Tawiah, A.K.;** Li A.; Jjunju, F.P.M.; Cooks, R.G. "Peptide Cross-linking at Ambient Surfaces by Reactions of Nanosprayed Molecular Cations" *Angew. Chem. Int. Ed.* **2012**, 51, 9417-9421
- 9. Muller, T.;** **Badu-Tawiah, A.K.;** Cooks, R.G. "Accelerated Carbon-Carbon Bond-Forming Reactions in Preparative Electrospray" *Angew. Chem. Int. Ed.* **2012**, 51, 11832 -11835
- 10. Jjunju, F.P.M.;** **Badu-Tawiah, A.K.;** Li, A.; Soparawalla, S.; Roqan, I.S.; Cooks, R.G. "Hydrocarbon Analysis Using Desorption Atmospheric Pressure Chemical Ionization" *Int. J. Mass Spectrom.* **2012**, in press, DOI:10.1016/j.bbr.2011.03.031

11. **Badu-Tawiah, A.K.**; Eberlin, L.S.; Ouyang, Z.; Cooks, R.G. “Chemical Aspects of the Extractive Methods of Ambient Ionization Mass Spectrometry” *Annu. Rev. Phys. Chem.* **2013**, 64, 481–505
12. Jjunju, F.P.M.; Li, A.; **Badu-Tawiah, A.K.**; Wei, P.; Li, L.; Ouyang, Z.; Roqan, I.S.; Cooks, R.G. “In-situ Analysis of Corrosion Inhibitors Using Portable Mass Spectrometer Coupled with Paper Spray Ionization” *Analyst* **2013**, 3740-3748

#### POSTDOCTORAL RESEARCH: HARVARD UNIVERSITY

1. **Badu-Tawiah, A.K.**; Thuo, M.M.; Bwambok, D.; Blok, J.F.; Barber, J.; Whitesides, G.M. “Selective Hydrocarbon Absorption from Water using Cellulose Materials” **2013**, in preparation
2. **Badu-Tawiah, A.K.**<sup>#</sup>; Lathwal, S.<sup>#</sup>; Al-Sayah, M.; Christodouleas, D.; Smith, B.; Sikes, H.; Whitesides, G.M. “Rapid Paper-based Malaria Diagnosis using Polymerization-based Amplification” **2013**, in preparation. <sup>#</sup> co-first authors

#### PATENTS

1. Cooks, R.G.; **Badu-Tawiah, A.K.**; Muller, T. “Droplet Accelerated Reaction” **2012** pending
2. Jjunju, P.M.F.; Li, A.; **Badu-Tawiah, A.K.**; Wei, P.; Roqan, I.S.; Cooks, R.G. “In-situ Analysis of Corrosion Inhibitors Using Portable Mass Spectrometer Coupled with Paper Spray Ionization” **2013** pending
3. **Badu-Tawiah, A.K.**; Thuo M.M.; Whitesides, M.G. “Selective Wetting on Functionalized-Cellulose Materials, and their Applications in Water Purification and Collection” **2013** pending
4. **Badu-Tawiah, A.K.**; Lathwal, S.; Al-Sayah, M.; Christodouleas, D.; Sikes, H.; Whitesides, M.G. “Time-independent Paper-based Disease Diagnosis using Polymerization-based Amplification” **2013** pending

#### PRESENTATIONS

##### INVITED

1. **Badu-Tawiah, A.K.**; Wu, C.; Cooks, R.G. “Ambient Ion Soft Landing and Surface Patterning” Dow BEST Symposium, Midland, IM, September 2010
2. **Badu-Tawiah, A.K.**; Wu, C.; Cooks, R.G. “Free Gas-Phase Ion Processing under Ambient Conditions” Turkey Run Analytical Conference; Indiana, November 2010

##### CONTRIBUTED

1. Venter, A.; Jackson, A. U.; Talaty N.; Oradu, S.; **Badu-Tawiah, A. K.**; Cooks, R. G. “Endogenous Metabolites Excreted Through the Skin Analyzed by Geometry Independent Desorption Electrospray Ionization” 56<sup>th</sup> American Society of Mass Spectrometry Conference, Colorado, June 2008
2. Cooks, R. G.; Wu, C.; **Badu-Tawiah, A. K.**; Huang, G. “Chemical Reactions in Ambient Ionization Mass Spectrometry and Soft Landing” 238<sup>th</sup> ACS National Meeting, Washington, DC, 2009
3. Cooks, R. G.; Cyraic, J.; **Badu-Tawiah, A. K.** “Condensed Phase Processes in the Mass Spectrometer” 242<sup>nd</sup> ACS National Meeting, Denver, CO, **2011**
4. Cooks, R.G.; Ifa, D.; **Badu-Tawiah, A.K.**; Noll, R. “Imaging by Ambient Ionization Mass Spectrometry” 22<sup>nd</sup> Annual Workshop on SIMS, Norfolk, VA, May 2010

## REFERENCES

NAME	RELATIONSHIP	TITLE/CONTACT INFORMATION
Prof. R. Graham Cooks	PhD Advisor	Henry B. Hass Distinguished Professor of Analytical Chemistry Department of Chemistry Purdue University 560 Oval Drive West Lafayette, IN 47907 Tel: 765-494-5263 Email: cooks@purdue.edu
Prof. George Whitesides	Post-Doc Advisor	Woodford L. and Ann A. Flowers University Professor Department of Chemistry and Chemical Biology Harvard University 12 Oxford Street Cambridge, MA 02138 Email: gwhitesides@gmwgroup.harvard.edu <i>Please send correspondence to staff assistant, Melissa LeGrand:</i> Email: mlegrand@gmwgroup.harvard.edu Tel: 617- 496-0958
Prof. John Ford	MS Advisor	Associate Professor of Chemistry Chemistry Department Indiana University of Pennsylvania Weyandt Hall, Room 143 Indiana, PA 15705 Tel: 724-357-5702 Email: jford@iup.edu
Prof. Hilikka Kenttamaa	PhD Committee	Professor of Analytical and Organic Chemistry Department of Chemistry Purdue University 560 Oval Drive West Lafayette, Indiana 47907 Tel: 765-494-0882 Email: hilikka@purdue.edu
Dr. Julia Laskin		Chief Scientist Pacific Northwest National Laboratory P.O. Box 999, K8-88 Richland, WA 99352 Tel: 509-371-6136 Fax: 509-371-6136 Email: julia.laskin@pnnl.gov

