 REQUIRED FORMAT FOR TITLE PAGE OF PROPOSAL

University Proposal # 6 of 12  
FOR PASSHE OFFICE USE ONLY: FPDC proposal #

Project Title: What Are You Breathing: Characterization of Indoor Toxic Air Pollutants

RFP Category: 1B  
Total Grant Amount Requested from FPDC: $ 2,790

Discipline: Chemistry  
Sub-Discipline: Environmental Chemistry

Project Director:
Dr. Min Li, Assistant Professor, Department of Chemistry and Physics, California University of Pennsylvania, 724-938-4152, li@calu.edu

Faculty Status (see definitions below):
☐ Tenured  ☑ Probationary  ☐ Non-Tenure Track

Other Participants:
None

IRB/IACUC Status: ☐ Approved (IRB # )  ☐ Pending  ☑ N/A

ABSTRACT (one paragraph of approximately 150 words in non-technical language):
Funding of this project will support my professional development effort of working as a Guest Researcher at National Institute for Occupational Safety and Health (NIOSH) in Pittsburgh, PA in summer 2011 & 2012. Through this collaborative effort, I will be able to work on an indoor toxic air pollution research with internationally recognized scientists at NIOSH. This proposed project will refine and then apply a rigorous protocol to detect toxic air pollutants in various indoor environments. My professional development will be enhanced in three areas upon completing the proposed project: establishing a new collaboration between Cal U and NIOSH, carving a new research area in detecting indoor air pollutants and producing multiple publications and presentations at regional and national level. The outcome of this project will benefit indoor air quality research field at a large scale and possibly future indoor air quality legislation.
**Background and Significance**

Toxic air pollutants, also known as hazardous air pollutants, are pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive or birth defects, or adverse environmental effects. The Clean Air Act Amendments of 1990 classified 187 chemical compounds as hazardous air pollutants. Most of these pollutants are Volatile Organic Compounds (VOCs). Indoor exposure to VOCs may cause higher risk of getting cancer or experiencing other serious health effects than outdoor exposure. This is because most people spend more time (up to 90%) indoors than outdoors in developed countries, such as U.S. Additionally, certain VOCs present at 2 to 10 times higher concentration level in indoor than outdoor environments (U.S.EPA, 1996). Human exposure is elevated by airtight indoor condition and low rate of air exchange for energy-saving purposes in modern buildings and houses. Indoor VOCs are ubiquitous but mainly originate from building materials and cleaning solvents in contrast to outdoor air toxics being from automobiles, industrial manufactures, refineries and power plants.

Detecting VOCs is one of the most challenging fields in environmental chemistry since there are a large number of different compounds defined as VOCs and they differ greatly in their physical and chemical properties. A large portion of VOCs exists as gas molecules in air at low concentration level and is highly unstable during sampling, storage and chemical analysis. This unique combination of low concentration and unstable nature causes relatively high errors in measuring VOCs. Most previous research focused on measuring VOCs level in a wide range of indoor environments, such as, residential homes, offices, schools and stores (Hippelein, 2006; Ohura, et al, 2009; Schlink, et al, 2010). However, only a hand full of research attempted to address the analytical error in the detection method (Narayan, et al, 2005; Kuntasal, et al, 2005; Zhu, et al, 2005; Larroque, et al, 2006 A; Ribes, et al, 2007). The complexity in sampling and analyzing gas molecules at trace levels in air has hindered the legislative action on protecting the public from hazardous chemical exposure. The proposed project aims to improve the method so more VOCs can be identified in indoor air and analysis errors can be reduced. However, California University is not currently equipped with the necessary facility to accomplish the project. As a result, I am seeking a collaboration with National Institute for Occupational Safety and Health (NIOSH) which is located about 20 miles north to California University for this project. NIOSH will be able to provide all relevant equipments for the project and is one of a few leading organizations world-wide in the field of indoor VOCs detection. This new collaboration between NIOSH and Cal U leads numerous avenues towards my professional growth, service to Cal U, potential grants and student internship opportunities.

My current research interest is in the area of detecting air pollutants in inhalable particulate matter which focuses on solid phase outdoor (Li et al, 2005; Li et al, 2006; McDow et al, 2008; Tang et al, 2008). However, I would like to expand to a new research area of gas phase air pollutants measurement in indoor environments due to the environmental chemistry challenge and the urgent need of assessing indoor chemical exposure. This proposed project will provide a hands-on opportunity for me to work as a “Guest Researcher” at NIOSH. My research expertise will be enhanced and broaden substantially upon completing the proposed project and continue to grow throughout my career. The research experience gained from the proposed collaboration will narrow my knowledge gap between solid phase and gas phase air pollutants as well as outdoor and indoor environments. I intend to incorporate the new research experience into teaching, research and scholarship development at California University.
The Department of Chemistry and Physics at California University is seeking grants to acquire a Gas Chromatography Mass Spectrometer (GCMS), which is the most commonly used instrument for analyzing both gas phase and solid phase organic pollutants. The proposed project will serve as a pilot study with a diverse application on GCMS and provide strong support for a following GCMS grant application.

Goals and Objectives
The objectives of this project are:

- Establish a collaboration with NIOSH, a leading organization in indoor air quality research
- Improve the detection method by increasing sensitivity and reducing errors
- Gain experience in gas pollutants sampling and analysis from indoor environments
- Measure VOC levels in various indoor environments near Cal U
- Provide preliminary data to support a grant proposal to the National Science Foundation Major Instrumentation Grant
- Share project results by presentations at University Academic Excellent Day, regional and national meetings and publish a peer-reviewed journal article

My long term professional development goals are:

- Strengthen my professional development by expanding to a new research area and diversifying the current research projects
- Establish an externally funded environmental chemistry research program at California University
- Enhance the chemistry curriculum in Department of Chemistry and Physics by offering more real world application in laboratory and research courses
- Publish in peer-reviewed journals and present at regional and national conferences

Description of Project
Phase I — Methodology

Phase I of the project focuses on improving VOC sampling and analysis techniques that were developed by NIOSH experts. Examples of VOC compounds include benzene, which is found in gasoline; perchlorehylene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper by a number of industries. The experiment portion of the project will take place in the analytical chemistry laboratory facility within National Personal Protective Technology Laboratory (NPPTL) at NIOSH Pittsburgh site during summers 2011 & 2012. As an in-kind contribution, NIOSH will provide all chemical supplies, VOC sampling equipments, and analytical instrumentation necessary for this project. Prior to arrival on NIOSH site in summer 2011, approximately 10 individual VOCs will be selected to be the “target compounds” based on their abundance in a particular environment, volatility and toxicity after literature review. The candidate VOCs to be considered include aromatic hydrocarbons (benzene, toluene, xylene), alcohols C$_1$-C$_4$, chlorinated hydrocarbons (methylene chloride and similar), C$_1$-C$_9$ aldehydes, phenols, Polycyclic Aromatic Hydrocarbons (PAHs), and Polychlorinated Biphenyls (PCBs). These species have been found in most indoor air of the U.S. and they typically have adverse health effects to some extent (Larroque et al., 2006 B; Srivastava et al., 2007).
The VOC sampling sites will be determined by NIOSH. The sampling devise to be used consists of (1) 1/4 inch stainless steel thermal desorption tubes, containing multi-bed sorbents capable of trapping VOC; (2) a personal sampling pump. Upon arrival of the field site, each personal pump will be calibrated and connected with one thermal tube that was cleaned prior to use. Field blanks and control samples (1 to 3 per set) will also be collected on site. All VOC samples will be kept in capped containers and transfer to NIOSH facility at ambient temperature, but stored at -10°C until analysis. One of the focuses in Phase I is to test a variety of combinations of commonly used sorbents including carbopacks, carboxen, Tenax and others to maximize the stability of trapped VOCs which will in turn reduce analysis errors.

At NPPTL / NIOSH facility, analysis of the sampled VOC will be carried out on Perkin-Elmer Automated Thermal Desorption 400 system interfaced directly to Agilent 6890/5973 Gas Chromatograph/Mass Spectrometer. During the thermal desorption process, VOCs are released as gas phase molecules from sorbents. Then the gas molecules go through gas chromatography and are detected by mass spectrometer. In order to improve the sensitivity and accuracy of the sampling and analysis method, I will implement a comprehensive Quality Assurance / Quality Control (QA/QC) plan during sampling, sample storage, and sample analysis procedure. Substantial effort will be made to (1) keep the samples free of contamination; (2) verify chromatographic background is clean with no carryover from previous runs; (3) avoid chemical reactions of VOC in sampling tubes. These efforts will contribute significantly to high quality samples and more accurate detection of VOCs.

Each of the ten target VOC compounds in the complex sample mixtures will be identified. Multiple analyses of a single sample may be possible in order to produce high quality chromatograms. Each VOC’s indoor concentration level in the samples will be determined using internal standard approach.

The complete analytical procedure will be evaluated for QA/QC parameters (detection limits, precision, accuracy, etc.). About 10% of the samples will be sampled and analyzed twice to estimate the precision of the procedure. If available from NIOSH, a known amount sample purchased from authentic sources will be analyzed to determine accuracy of the analytical procedure. Phase I of the project will result in an EXCEL database with the indoor concentrations of the 10 target VOCs together with QA/QC information such as but not limited to procedure and field blank level, recovery, detection limit, precision and accuracy.

Phase II — Application

Phase II focuses on applying the technique gained from Phase I in sampling and analysis of VOCs at different environmental settings. I will collect samples in residential homes with a minimum of 3 homes in Pittsburgh vicinity, one new computer lab, 3 chemistry labs, 2-3 classrooms on Cal U campus in the spring semester 2012. A minimum of 3 samples at each sampling site are necessary for providing sufficient VOC for analysis and covering temporary variation. The VOC sampling and storage supplies will be supported by NIOSH as in-kind contribution. The Cal U VOC samples will be stored in containers at -10°C until summer 2012 when analysis will begin at NIOSH. Phase II will result in a similar database as Phase I.

Overall, this project will generate original results of indoor chemical exposure which is valuable for risk and hazard assessment and public health monitoring managed by federal and local governments. Ultimately, monitoring indoor air pollution is to prevent any potential damage that human may be exposed.
**Timeline of The Project:**

<table>
<thead>
<tr>
<th>Period</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>May – June 2011</td>
<td>Begin the phase I of the project. Scientific literature review starts. Communicate with Dr. Zhuang at CDC/NIOSH to obtain federal government clearance on access to NIOSH facility and start paper work for the “Guest Researcher” appointment.</td>
</tr>
<tr>
<td>July – August 2011</td>
<td>Commute to NIOSH research lab to gain experience in VOC sampling and analysis. Process NIOSH samples and try to improve the recovery and accuracy of the analysis of the interested VOCs.</td>
</tr>
<tr>
<td>January – April 2012</td>
<td>Prepare for Phase II. Collect samples in residential homes, new computer labs, chemistry labs, classrooms at Cal U. Present at Cal U Academic Excellent Day.</td>
</tr>
<tr>
<td>May – June 2012</td>
<td>Analyze Cal U samples in NIOSH lab facility. Begin a manuscript to be submitted to AWMA Journal and/or Journal of Chromatography. Present at AWMA Annual Conference June 2012.</td>
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<tr>
<td>July 2012</td>
<td>Compile data file and start data reduction and interpretation. Summarize major findings and QA/QC results.</td>
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<tr>
<td>August 2012</td>
<td>Present results at ACS Annual Conference August 2012.</td>
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<tr>
<td>October 2012</td>
<td>Project is completed and report is submitted to PASSHE FPDC.</td>
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**Expected Outcomes**
My professional development will be enhanced in a number of ways upon completing this project:
- Establish a new collaboration between California University and NIOSH. Cal U student and faculty may obtain access to NIOSH facility when needed for research in the future. Potential research grant applications target on NIOSH research programs
- Provide pilot study results for a NSF major instrument grant proposal acquiring a GCMS for the Department of Chemistry and Physics, California University
- Publish toxic air pollutants concentration levels measured in various indoor environments in peer reviewed journals. This will be a valuable contribution to the indoor air quality and environmental chemistry fields
- Improve the current detection methods for higher sensitivity and accuracy
- Present at national conferences and Cal U’s research events
- Broaden my research area by adding gas phase indoor study to the current solid phase outdoor experience for toxic air pollutants
- Diverse the environmental chemistry research projects offered to senior chemistry major students

**Compliance with University Research Requirements**
This project complies with all University regulations. It does not involve use of vertebrates or human test subjects and therefore does not require IRB approval.
## Budget Summary

<table>
<thead>
<tr>
<th>Project Budget</th>
<th>Proposed Grant</th>
<th>University Contribution</th>
<th>Other Revenue Sources</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries/Stipends</td>
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<td>Student Wages</td>
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<td>Benefits</td>
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<td>Honoraria (for consultants)</td>
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<tr>
<td>Supplies</td>
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<tr>
<td>Equipment</td>
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<td>Operating Expenses</td>
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<td>$240</td>
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<tr>
<td>Other (specify)</td>
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<td><strong>TOTALS</strong></td>
<td><strong>$2,790</strong></td>
<td><strong>$450</strong></td>
<td><strong>$7,800</strong></td>
<td><strong>$11,040</strong></td>
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*Salaries/Stipends*: summer 2011: \( \frac{3}{4} \times \$2,000 = \$1,500 \) (3 weeks full time equivalent), summer 2012: \( \frac{1}{2} \times \$2,000 \) (2 weeks full time equivalent) = \$1,000. Total salaries is \$2,500 for 2 summers. Due to the complex nature of analyzing low level gas molecules in air, a minimum 3 weeks (summer 2011) is needed to master the technical skill on instrumentation. A minimum of 2 weeks is required to analyze CalU samples at NIOSH facility.

*Benefits*: Benefit is contributed by California University at \( \$2,500 \times 18\% = \$450 \)

*Equipment*: In-kind contribution from NIOSH in total of \$7,800. See Dr. Zhuang’s supporting letter for itemized amount.

*Operating Expenses*: \$50 for phone, printing posters, copying, paper supplies that not covered by NIOSH and California University

*Travel expense*: accounts for commute to NIOSH facility located at 626 Cochrans Mill Road Pittsburgh, PA 15236 from home (15 miles x \$0.50/mile) per round trip x 32 trips for 2 summers = \$240. Gasoline reimbursement rates were taken from California University travel reimbursement rates.
Reference:


5) Li, Min; McDow, Stephen R.; Tollerud, David; Mazurek, Monica A., 2005. Quantitation, detection and measurement precision of molecular markers in urban particulate matter from Philadelphia, PA, *AWMA’s 98th Annual Conference & Exhibition Proceedings, Minneapolis, Minnesota 2005*.


10) Ribes, Alejandra; Carrera, Guillem; Gallego, Eva; Roca, Xavier; Berenguer, José; Guardino, Xavier., 2007. Development and validation of a method for air-quality and nuisance odors monitoring of volatile organic compounds using multi-sorbent adsorption and gas


Curriculum Vitae
Min Li, Ph.D
Assistant Professor
Department of Chemistry and Physics
California University of Pennsylvania, California, PA 15149
Email: li@calu.edu, Phone: (724) 938-4152

Education:
2003       Ph.D., Environmental Engineering, Drexel University
1999       M.S., Environmental Engineering, Tianjin University, China
1996       B.E., Environmental Engineering, Hebei University of Science and Technology, China

Honors:
2009       Faculty Professional Development Center Travel Award, California University of Pennsylvania
2006       Early Career and New Faculty Scientist travel awards for participation in the “Air Quality Remote Sensing from Space” workshop to be held at NCAR, Boulder CO, USA, February 21-23, 2006. Funding for this support is being provided by NSF, NASA and NCAR.
2002       Delaware Valley Chapter of the Air & Waste Management Association (A&WMA) Scholarship Award
2001       Poster Session Award at Drexel and MCP Hahnemann Universities Third Annual Research Day

Professional Experience:
2008 Fall to present
   Assistant Professor of Environmental Chemistry, Department of Chemistry and Physics, California University of Pennsylvania
2007 Fall
   Adjunct Professor of Environmental Chemistry, Department of Chemistry, Manhattanville College, Purchase, NY
2004 to present
   Research Associate, Department of Civil and Environmental Engineering, Rutgers University
2003 to 2004
   Postdoctoral Research Associate, Department of Civil and Environmental Engineering, Rutgers University
1999 to 2003
   Teaching Assistant, Graduate Research Assistant, School of Environmental Science, Engineering and Policy, Drexel University

Memberships in Professional Organization:
Air & Waste Management Association
American Association for Aerosol Research
American Chemical Society
Grants

1. Dr. Kyle Fredrick (PI), Min Li (co-PI) and Tom Muller (co-PI), California University of Pennsylvania. Pike Run: A Vision for the Future of Watershed, funded by Pennsylvania American Water, $5,400, July-December 2009.

2. Dr. Monica Mazurek (PI), Min Li (co-PI), Rutgers University, Chemical Composition of Fine Particulate Emissions from Light-Duty Gasoline, Diesel and CNG Vehicles, funded by New York State Energy Research and Development Authority, $300,000, 2009-2012.

Publications:


Support Letter for Dr. Min Li's Collaborative Research at NIOSH

Dear FPDC Review Committee:

This letter is to support Dr. Min Li's application for the annual grant from PASSHE FPDC 2010-2011. Dr. Li will be appointed as a "Guest Researcher" from July 2011 to October 2012 in National Personal Protective Technology Laboratory (NPPTL), as a part of National Institute for Occupational Safety and Health (NIOSH) administrated by Department of Health & Human Services of U.S.. The NPPTL is in strong interest of establishing collaboration with Dr. Li in developing detection methods for toxic air pollutants in various indoor work environments as well as outdoor atmosphere. During Dr. Li's appointment, she will be able to participate in projects in NPPTL/NIOSH such as monitoring volatile organic compound (VOC) in surgical room of hospitals and developing new sensor for indoor VOC measurement. This collaboration will strengthen technology transfer and outreach from NIOSH to California University of Pennsylvania. The collaborative research is one of the prioritized research areas that NIOSH has designated for the next few years.

The office space and research supplies for her work will be provided by NIOSH. Please refer to the next page for the list of supplies and equipments provided. I will arrange for Dr. Li to obtain accesses to NIOSH research laboratory facilities she may need for the period of time.

Please contact me by email (zaz3@cdc.gov) if you need more details about this collaborative research project with Dr. Li.

Sincerely,

[Name Redacted]

Senior Research Scientist and Team Leader
# In-Kind Contribution from CDC/NIOSH/NPPTL

<table>
<thead>
<tr>
<th>Supplies</th>
<th>Values in US$</th>
</tr>
</thead>
<tbody>
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<td>Chemicals</td>
<td>$800</td>
</tr>
<tr>
<td>Glassware</td>
<td>$600</td>
</tr>
<tr>
<td>Instruments (GCMS run time)</td>
<td>$5000</td>
</tr>
<tr>
<td>Consumables (sorbents, sample vials, filters, etc.)</td>
<td>$700</td>
</tr>
<tr>
<td>Computers and software</td>
<td>$600</td>
</tr>
<tr>
<td>Office supplies</td>
<td>$100</td>
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</table>