Final Progress Report for Research Projects Funded by Health Research Grants

Instructions: Please complete all of the items as instructed. Do not delete instructions. Do not leave any items blank; responses must be provided for all items. If your response to an item is "None", please specify "None" as your response. "Not applicable" is not an acceptable response for any of the items. There is no limit to the length of your response to any question. Responses should be single-spaced, no smaller than 12-point type. The report **must be completed using MS Word**. Submitted reports must be Word documents; they should not be converted to pdf format.

1. **Grantee Institution:** Drexel University

2. **Reporting Period (start and end date of grant award period):** 1/1/2010-12/31/2013

3. **Grant Contact Person (First Name, M.I., Last Name, Degrees):** Anne Martella

4. **Grant Contact Person's Telephone Number:** (215) 895-6471

5. **Grant SAP Number:** 4100050893

6. **Project Number and Title of Research Project**: 9 - *Microfabricated QLISA Biosensor with Embedded Heating and Mixing Elements*

7. **Start and End Date of Research Project:** 1/1/2010 - 6/30/2011

8. **Name of Principal Investigator for the Research Project:** Elisabeth Papazoglou, PhD (died August 17, 2011)

9. **Research Project Expenses**.

   9(A) Please provide the total amount of health research grant funds spent on this project for the entire duration of the grant, including indirect costs and any interest earned that was spent:

   $111,839

   9(B) Provide the last names (include first initial if multiple individuals with the same last name are listed) of **all** persons who worked on this research project and were supported with health research funds. Include position titles (Principal Investigator, Graduate Assistant, Post-doctoral Fellow, etc.), percent of effort on project and total health research funds expended for the position. For multiple year projects, if percent of effort varied from year to year, report in the % of Effort column the effort by year 1, 2, 3, etc. of the project (x% Yr 1; z% Yr 2-3).

Last Name, First Name	Position Title	% of Effort on Project	Cost
Papazoglou, Elizabeth	Associate Professor	5%	$6,610
Babu, Sundar	Research Ass. Professor	67%	$42,568
Yu, Chengjie	Research Assistant	82%	$19,600

9(C) Provide the names of **all** persons who worked on this research project, but who *were not* supported with health research funds. Include position titles (Research Assistant, Administrative Assistant, etc.) and percent of effort on project. For multiple year projects, if percent of effort varied from year to year, report in the % of Effort column the effort by year 1, 2, 3, etc. of the project (x% Yr 1; z% Yr 2-3).

Last Name, First Name	Position Title	% of Effort on Project
Noh, Hongseok (Moses)	Assistant Professor	5%
Nadarajan, Sundar Babu	Research Assistant Professor	5%
Murthy, Sreekant	Professor	5%

9(D) Provide a list of **all** scientific equipment purchased as part of this research grant, a short description of the value (benefit) derived by the institution from this equipment, and the cost of the equipment.

Type of Scientific Equipment	Value Derived	Cost
None		

10. Co-funding of Research Project during Health Research Grant Award Period. Did this research project receive funding from any other source during the project period when it was supported by the health research grant?

Yes_____ No_____x____

If yes, please indicate the source and amount of other funds:

11. Leveraging of Additional Funds

11(A) As a result of the health research funds provided for this research project, were you able to apply for and/or obtain funding from other sources to continue or expand the research?

Yes_____ No____x___

If yes, please list the applications submitted (column A), the funding agency (National Institutes of Health—NIH, or other source in column B), the month and year when the application was submitted (column C), and the amount of funds requested (column D). If

you have received a notice that the grant will be funded, please indicate the amount of funds to be awarded (column E). If the grant was not funded, insert "not funded" in column E.

Do not include funding from your own institution or from CURE (tobacco settlement funds). Do not include grants submitted prior to the start date of the grant as shown in Question 2. If you list grants submitted within 1-6 months of the start date of this grant, add a statement below the table indicating how the data/results from this project were used to secure that grant.

A. Title of research project on grant application	B. Funding agency (check those that apply)	C. Month and Year Submitted	D. Amount of funds requested:	E. Amount of funds to be awarded:
None	☐NIH ☐ Other federal (specify:_____) ☐ Nonfederal source (specify:_)		$	$

11(B) Are you planning to apply for additional funding in the future to continue or expand the research?

Yes_____ No_____x____

If yes, please describe your plans:

12. Future of Research Project. What are the future plans for this research project?

PI died 8/17/2011

13. New Investigator Training and Development. Did students participate in project supported internships or graduate or post-graduate training for at least one semester or one summer?

Yes_____ No____x_____

If yes, how many students? Please specify in the tables below:

	Undergraduate	Masters	Pre-doc	Post-doc
Male				
Female				
Unknown				
Total				

	Undergraduate	Masters	Pre-doc	Post-doc
Hispanic				
Non-Hispanic				
Unknown				
Total				

	Undergraduate	Masters	Pre-doc	Post-doc
White				
Black				
Asian				
Other				
Unknown				
Total				

14. Recruitment of Out-of–State Researchers. Did you bring researchers into Pennsylvania to carry out this research project?

Yes_____ No____x_____

If yes, please list the name and degree of each researcher and his/her previous affiliation:

15. Impact on Research Capacity and Quality. Did the health research project enhance the quality and/or capacity of research at your institution?

Yes_____ No_____x_____

If yes, describe how improvements in infrastructure, the addition of new investigators, and other resources have led to more and better research.

16. Collaboration, business and community involvement.

16(A) Did the health research funds lead to collaboration with research partners outside of your institution (e.g., entire university, entire hospital system)?

Yes_____ No_____x____

If yes, please describe the collaborations:

16(B) Did the research project result in commercial development of any research products?

Yes_____ No_____x_____

If yes, please describe commercial development activities that resulted from the research project:

16(C) Did the research lead to new involvement with the community?

Yes_____ No_____x_____

If yes, please describe involvement with community groups that resulted from the research project:

17. Progress in Achieving Research Goals, Objectives and Aims.

List the project goals, objectives and specific aims (as contained in the grant agreement). Summarize the progress made in achieving these goals, objectives and aims for the period that the project was funded (i.e., from project start date through end date). Indicate whether or not each goal/objective/aim was achieved; if something was not achieved, note the reasons why. Describe the methods used. If changes were made to the research goals/objectives/aims, methods, design or timeline since the original grant application was submitted, please describe the changes. Provide detailed results of the project. Include evidence of the data that was generated and analyzed, and provide tables, graphs, and figures of the data. List published abstracts, poster presentations and scientific meeting presentations at the end of the summary of progress; peer-reviewed publications should be listed under item 20.

This response should be a DETAILED report of the methods and findings. It is not sufficient to state that the work was completed. Insufficient information may result in an unfavorable performance review, which may jeopardize future funding. If research findings are pending publication you must still include enough detail for the expert peer reviewers to evaluate the progress during the course of the project.

Health research grants funded under the Tobacco Settlement Act will be evaluated via a performance review by an expert panel of researchers and clinicians who will assess project work using this Final Progress Report, all project Annual Reports and the project's strategic plan. After the final performance review of each project is complete, approximately 12-16 months after the end of the grant, this Final Progress Report, as well as the Final Performance Review Report containing the comments of the expert review panel, and the grantee's written response to the Final Performance Review Report, will be posted on the CURE Web site.

There is no limit to the length of your response. Responses must be single-spaced below, no smaller than 12-point type. If you cut and paste text from a publication, be sure symbols print properly, e.g., the Greek symbol for alpha (α) and beta (ß) should not print as boxes (□) and include the appropriate citation(s). DO NOT DELETE THESE INSTRUCTIONS.

Summary of Research Completed

Aim 1: Design, fabrication, and testing of a PMMA microchannel for QLISA - Completed
Thermoplastic Microfluidic Device Fabrication: We selected hot embossing as the preferred method to develop our prototype polymethylmethacrylate (PMMA) microchannel design, because a single mold insert can be rapidly manufactured and enable fast and reproducible manufacture of PMMA microchannels. A 2.5" square copper mold insert with raised microstructures was made (via photolithography and electroplating) and these raised microstructures were then transferred to the PMMA substrate via hot embossing to create microstructures within the PMMA substrate. Lastly, the device was sealed using a solvent assisted bonding technique. An overview of this process is presented in Figure 1 and a more detailed description of this process is provided in what follows.

Photolithoraphy: The fabrication process begins with a photomask, which in this case is a clear field mask. A simple photomask was first designed in order to optimize the fabrication procedure and demonstrate proof of concept for subsequent immunoassay reactions. The photomask consisted of microchannels of various widths (50, 100 and 250um) and pitches (5, 7.5 and 10mm) between microchannels. The photomask was first designed using AutoCAD 2010 and sent to Advanced Reproductions for printing. Upon receipt, the thin film photomask was replicated to create a more durable chrome mask. Once the photomask pattern was transferred to a chrome photomask, photolithography was performed on a cleaned 1mm thick 2.5" copper substrate. SU-8 2150 photoresist (Microchem) was then spun onto the substrate at 500rpm for 10 seconds followed by spinning at 17000rpm (300r/s acceleration) for 30 seconds to produce a final thickness of approximately 200um. The copper plate was then placed onto a hot plate and baked at 60°C for 20 minutes followed by a 40 minute bake at 90°C (softbake). The coated substrate was then cooled to room temperature and exposed to 28mW/cm^2 for 17 seconds (476mJ/cm^2). Following exposure, the photoresist patterned substrate was placed onto a hot plate and baked at 65°C for one hour (a latent image of the pattern should not be visible until minutes into the post exposure bake, if a latent image is seen the pattern was likely overexposed). The patterned substrate is then cooled to room temperature and developed for ten minutes in SU-8 developer under manual agitation. The end product (micropatterned SU-8 on copper substrate) is shown in Figure 2.

Electroplating: After manufacture of the SU-8 micropatterned copper substrate, copper electroplating was performed to create raised microchannel structures on the copper substrate. First, the patterned substrate was cleaned extensively with acetone followed by a rinse in DI water and air-dried. The patterned copper plate was then placed into a holder 35cm from a bare copper plate (cleaned with acetone & DI water). The apparatus was then submerged in a copper electroplating solution (200g copper (II) sulfate pentahydrate, 25ml of concentrated H_2SO_4 in 1mL of deionized water) with an applied DC current of 0.2A for 1 hour under stir bar agitation. These conditions represent our optimized methods for producing uniform raised microchannel structures of 120um in height which were measured by surface profilometry.

Hot Embossing & Coupon Sealing: Following fabrication of the micropatterned copper mold insert, hot embossing was performed to create microchannel grooves on the PMMA substrate. 1cm thick PMMA sheets were cut into 2" squares, cleaned and dried. Once clean a piece of

PMMA was sandwiched between a glass plate and the copper mold insert and loaded into a Carver heat press. Both the top and bottom platens were then brought into contact with the copper mold insert and glass plate respectively and set to 140°C. Once the temperature of the platens reached 110°C a pressure of 250psi was applied to the PMMA sheet for a period of 5 minutes and then the platens were cooled to room temperature within the press. A second 2" wide, 1cm thick PMMA sheet was soaked in ethanol for 5 minutes, then brought into contact with the molded PMMA piece and loaded into the Carver heat press between two pieces of glass. The platens were heated to 75°C under a pressure of 250psi for 5 minutes. The sealed microchannel coupon was then immediately removed from the press and the lumen of the channels was rinsed thoroughly with DI water.

Aim 2: Enhanced sensitivity by physical and chemical modification of channels- Completed with available instrumentation – Goal was achieved with chemical modification
In this Aim we focused and completed the chemical modification step. The laser ablation equipment is still being evaluated after its delayed installation at the Drexel Laboratory.

Thermoplastic Microfluidic Device Validation: Once the microfluidic device was successfully designed and manufactured, an initial proof of concept experiment was performed in order to characterize the performance of a sandwich assay for the detection of lactoferrin within the microchannels. In order to perform these experiments, the lumen of the microchannels was modified by covalently immobilizing polyclonal lactoferrin antibodies using a variety of surface functionalization / modification methods. The microchannels served as the substrate for the subsequent assay. Data on the surface coverage of antibodies on PMMA substrates demonstrate that the optimal functionalization density is achieved with PEG functionalization as compared to PEI or EDC/NHS chemistries. Therefore, we offer details of the PEGylation method only.

PEG Microchannel Functionalization: We have developed a novel surface modification technique in order to increase antibody surface coverage within the PMMA microchannels. First, microchannel surface was activated by circulating 1N NaOH at a rate of 100ul/min, for 1 hour at 60^{o}C. Each microchannel was then rinsed with 1X PBS pH 7.4 and 0.2% PEG solution was circulated at 100ulmin for 1 hour). Following a rinse with Tween surfactant and PBS, a 1% glutaraldehyde solution was circulated at 100ul/min for 30 minutes. Following a second rinse, 500nM polyclonal lactoferrin antibody (500nM) was incubated within the microchannels at 37°C for one hour. Each microchannel was then rinsed with 1ml of 0.05% Tween (1X PBS @7.4) followed by a rinse with 1ml of 1X PBS. An overview of this process is shown in Figure 3.

Antibody Surface Coverage: We have quantitatively determined the surface density of antibody coverage by immobilizing Alexafluor conjugated antibodies onto the surface of PMMA channels using the chemistries outlined above. A standard calibration curve was used to quantify antibody coverage. Our results demonstrated that the PEG/glutaraldehyde method achieves 4-fold immobilization of antibody as compared to passive adsorption, 40% more coverage compared to EDC/sulfoNHS functionalization and more than 30% coverage compared to any PEI functionalization.

Lactoferrin Assay Procedure: After antibody immobilization, five microchannels were

incubated with lactoferrin antigen at 50, 100, 200, 400 and 800ng/ml respectively for 40 minutes at 37°C (positive control and standard dilutions). The microchannels were washed with 200ul 0.01% Tween followed by a wash with 200ul 1X PBS pH 7.4, and incubated with 100nM QD-Ab solution for 40 minutes at 37°C. After a standard wash the microchannel were imaged using the optical setup shown below in Figure 5. Our results demonstrated that we were able to detect lactoferrin at levels down to 50ng/ml (Figure 6). An additional optical characterization was carried out in order to compare the sensitivity of our previously published capillary setup with this newly developed microfludic device (Figure 7). These data suggest that the microfludic device has higher sensitivity than the capillary setup (19.5 and 15.7 AU/(ng/ml) respectively).

Aim 3: Incorporation of electrokinetic mixing onto the PMMA microchannel
Electrokinetic mixing was achieved on a glass substrate which would then be bonded to the PMMA channel device manufactured and validated in Aims 1 and 2.

Electrothermal mixing device: AC Electrothermal Effect (ETE) refers to fluid motion induced by temperature gradients in the fluid in the presence of AC electric fields. It is caused by uneven Joule heating of the fluid, which induces gradients of conductivity and permittivity, and as a result charges in the fluid bulk move under the influence of the electric fields to generate flows. We have developed the ETE device shown in Figure 8. They were fabricated on a silicon substrate by depositing a 200 nm silicon dioxide isolation layer and parallel chromium–gold electrodes. The electrodes (10nm Cr-100nm Au) are 9 mm long and are separated by 60 mm gaps. Although there are four parallel electrodes, only the center two electrodes were used in this application. A Peltier cooler was applied to enhance the ETE. The experiments were conducted in 1X PBS. The conductivity of 1X phosphate buffer solution (PBS) is 1.77S/m. The voltage applied in these experiments ranged from 5Vrms to 10Vrms. Although different frequencies were tested in the experiment, the 200kHz of frequency is the default setting for most of the tests. 2um and 10um polystyrene microbeads were used to observe the motion in fluid.

Demonstration of electrothermal effect (ETE): First of all, ETE is more pronounced at higher ionic strength fluid, e.g., PBS. Another fluid driving force caused by AC electric field, ACEO, is inhibited in such condition. Secondly, because ETE is caused by temperature gradient, ETE can be enhanced by increasing the temperature gradient. By applying a Peltier cooler, electrothermal mixing was improved (Figure 9). Without the effect of the Peltier cooler, the mixing was restricted only to the right side of the electrodes, which are closest to the power supplier. However, after using the Peltier cooler for 1 min, mixing occurred throughout the electrode area covered by PBS. When turning off the cooler for 10 min, mixing returned to its previous stage, i.e. only happening at the right side of electrodes. Due to this behavior, we are confident that the mixing observed was mainly caused by an AC electrothermal effect. Because of electrode resistance the voltage drops and fluid velocity decreases as the distance from the electric source is increased. In addition to the vertical rotation movement on the Y plane, there is lateral movement along the X direction down towards the ends of the electrodes (Figure 10).

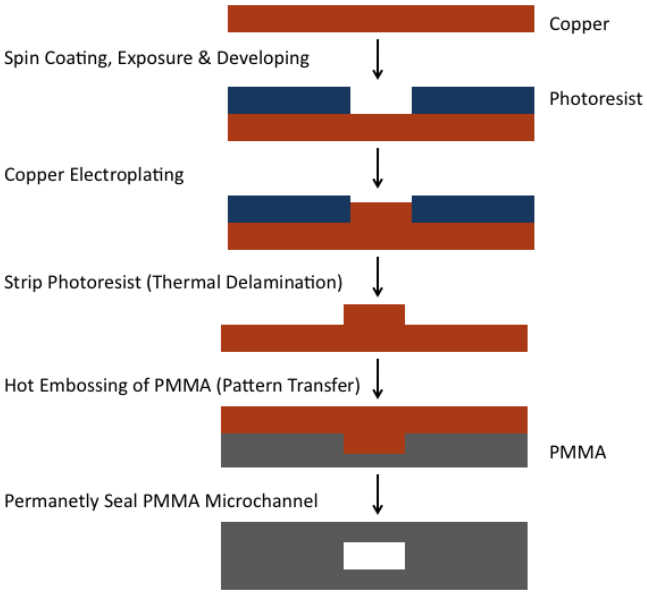

Figure 1: Profile view of the PMMA microchannel fabrication processs. First, the copper is cleaned and patterned with 250u thick negative photoresist (SU-8 2150), creating an active site for copper electroplating in the subsequent step to produce raised microchannel features on a copper substrate (mold insert). The mold insert is then used as a die in the subsequent hot embossing process to produce a microchannel in the desired PMMA substrate. The device is then sealed with a PMMA cover, effectively creating an array of sealed microchannels.

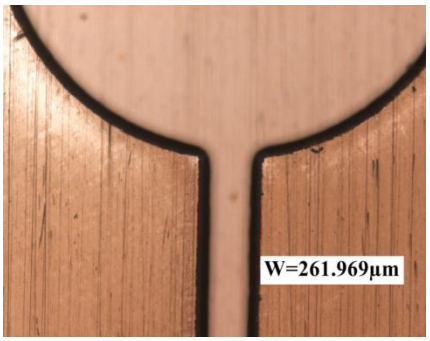

Figure 2: SU-8 patterned copper substrate. The raised SU-8 may be seen on top of the copper substrate. The final width of the microchannel was approximately 260um. The exposed (developed) regions of the SU-8 serve as a substrate for the adhesion of copper during the subsequent electroplating process.

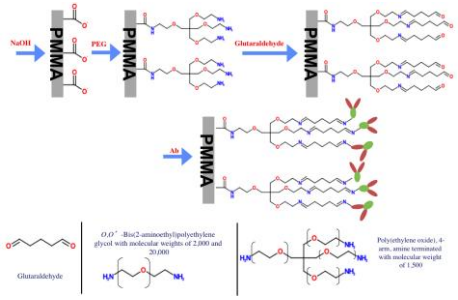

Figure 3.
Overview of PEG functionalization chemistry.

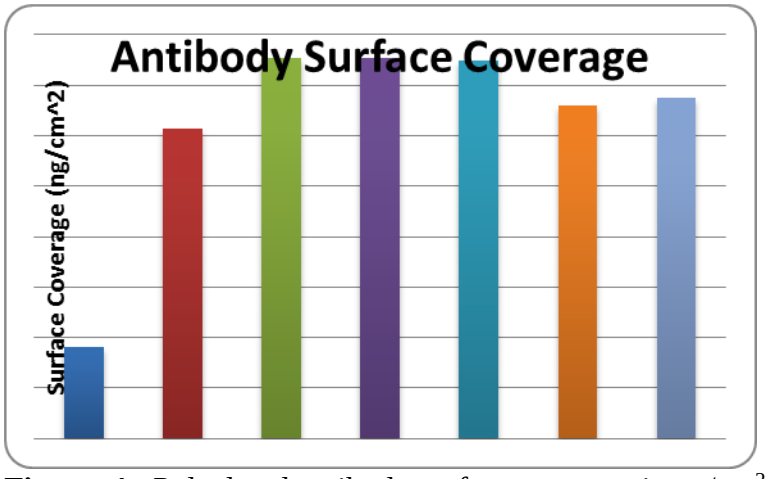

Figure 4: Polyclonal antibody surface coverage in ng/cm^2

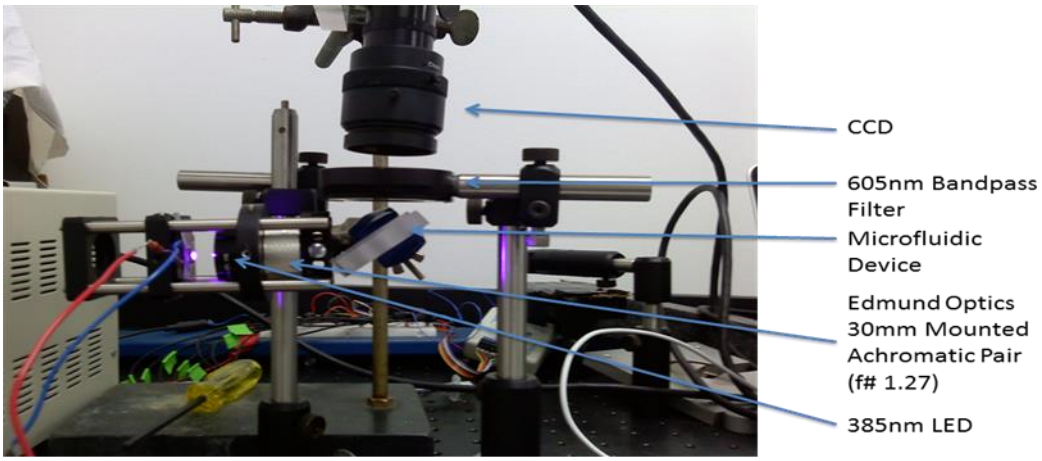

Figure 5: Optical setup designed to detect fluorescence from the PMMA microfluidic channel device.

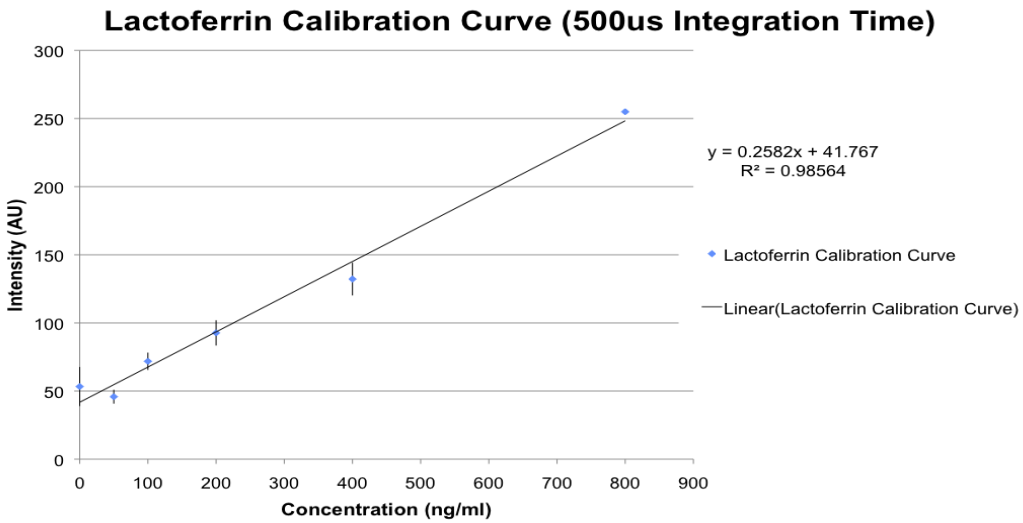

Figure 6: Lactoferrin calibration curve obtained using the microfluidic PMMA platform.

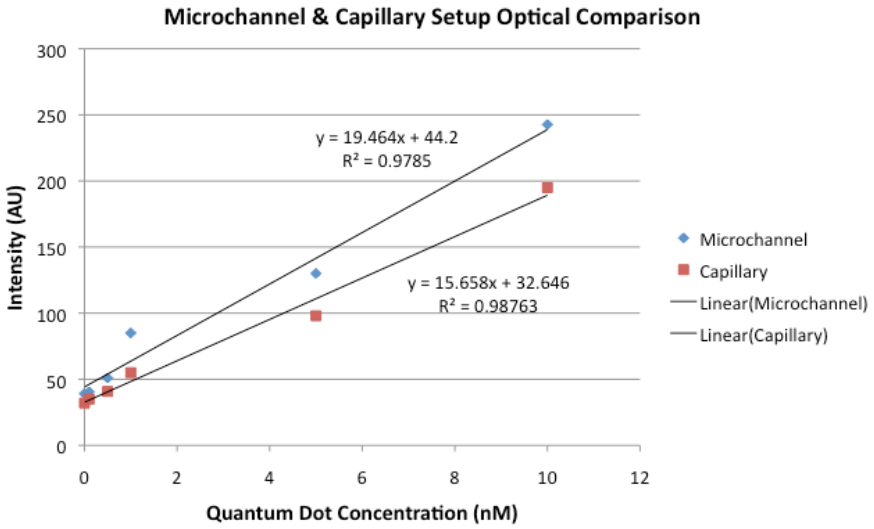

Figure 7: Optical comparison of the capillary and microfluidic channel device obtained using quantum dot solutions of varying concentrations

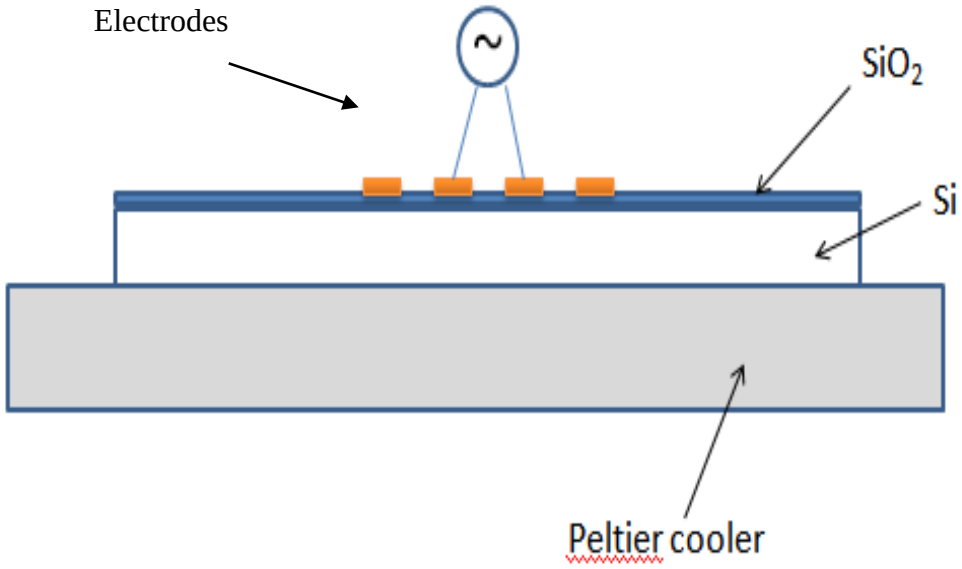

Figure 8: Experimental ETE device. The silicon substrate is isolated with a silicon dioxide layer from Cr-Au electrodes separated by 60 mm gaps.

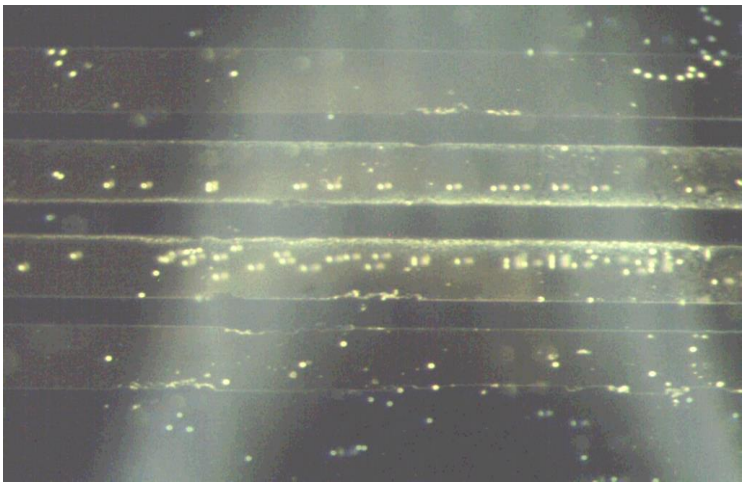

Figure 9: After applying 10Vrms at the middle two electrodes, polystyrene microbeads were attracted by ETE, rotating on two lines.

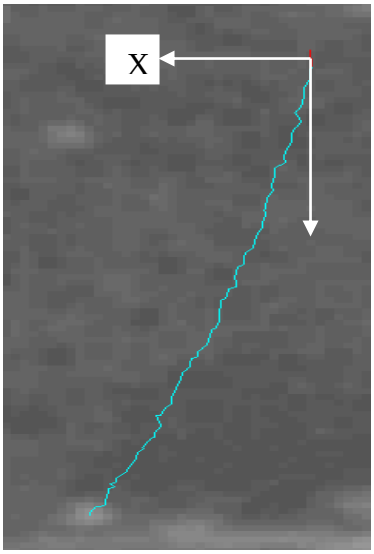

Figure 10: Tracking of the particles by video analysis of images shows that particles rotate on the plane perpendicular to the substrate surface due to ETE, and at the same time, they travel downwards towards the ends of the electrodes because of energy loss along the fingers.

18. Extent of Clinical Activities Initiated and Completed. Items 18(A) and 18(B) should be completed for all research projects. If the project was restricted to secondary analysis of clinical data or data analysis of clinical research, then responses to 18(A) and 18(B) should be "No."

18(A) Did you initiate a study that involved the testing of treatment, prevention or diagnostic procedures on human subjects?

_____Yes
__x___No

18(B) Did you complete a study that involved the testing of treatment, prevention or diagnostic procedures on human subjects?

_____Yes
___x__No

If "Yes" to either 18(A) or 18(B), items 18(C) – (F) must also be completed. (Do NOT complete 18(C-F) if 18(A) and 18(B) are both "No.")

18(C) How many hospital and health care professionals were involved in the research project?

_____Number of hospital and health care professionals involved in the research project

18(D) How many subjects were included in the study compared to targeted goals?

_____Number of subjects originally targeted to be included in the study
_____Number of subjects enrolled in the study

Note: Studies that fall dramatically short on recruitment are encouraged to provide the details of their recruitment efforts in Item 17, Progress in Achieving Research Goals, Objectives and Aims. For example, the number of eligible subjects approached, the number that refused to participate and the reasons for refusal. Without this information it is difficult to discern whether eligibility criteria were too restrictive or the study simply did not appeal to subjects.

18(E) How many subjects were enrolled in the study by gender, ethnicity and race?

Gender:
_____Males
_____Females
_____Unknown

Ethnicity:
_____Latinos or Hispanics
_____Not Latinos or Hispanics
_____Unknown

Race:
_____American Indian or Alaska Native
_____Asian
_____Blacks or African American
_____Native Hawaiian or Other Pacific Islander
_____White
_____Other, specify:_____
_____Unknown

18(F) Where was the research study conducted? (List the county where the research study was conducted. If the treatment, prevention and diagnostic tests were offered in

more than one county, list all of the counties where the research study was conducted.)

19. Human Embryonic Stem Cell Research. Item 19(A) should be completed for all research projects. If the research project involved human embryonic stem cells, items 19(B) and 19(C) must also be completed.

19(A) Did this project involve, in any capacity, human embryonic stem cells?
_____Yes
___x__ No

19(B) Were these stem cell lines NIH-approved lines that were derived outside of Pennsylvania?
_____Yes
_____ No

19(C) Please describe how this project involved human embryonic stem cells:

20. Articles Submitted to Peer-Reviewed Publications.

20(A) Identify all publications that resulted from the research performed during the funding period and that have been submitted to peer-reviewed publications. Do not list journal abstracts or presentations at professional meetings; abstract and meeting presentations should be listed at the end of item 17. **Include only those publications that acknowledge the Pennsylvania Department of Health as a funding source** (as required in the grant agreement). List the title of the journal article, the authors, the name of the peer-reviewed publication, the month and year when it was submitted, and the status of publication (submitted for publication, accepted for publication or published.). Submit an electronic copy of each publication or paper submitted for publication, listed in the table, in a PDF version 5.0.5 (or greater) format, 1,200 dpi. Filenames for each publication should include the number of the research project, the last name of the PI, and an abbreviated title of the publication. For example, if you submit two publications for Smith (PI for Project 01), one publication for Zhang (PI for Project 03), and one publication for Bates (PI for Project 04), the filenames would be:

Project 01 – Smith – Three cases of isolated
Project 01 – Smith – Investigation of NEB1 deletions
Project 03 – Zhang – Molecular profiling of aromatase
Project 04 – Bates – Neonatal intensive care

If the publication is not available electronically, provide 5 paper copies of the publication.

Note: The grant agreement requires that recipients acknowledge the Pennsylvania Department of Health funding in all publications. Please ensure that all publications listed acknowledge the Department of Health funding. If a publication does not acknowledge the funding from the Commonwealth, do not list the publication.

Title of Journal Article:	Authors:	Name of Peer-reviewed Publication:	Month and Year Submitted:	Publication Status (check appropriate box below):
1. None				☐Submitted ☐Accepted ☐Published

20(B) Based on this project, are you planning to submit articles to peer-reviewed publications in the future?

Yes_____ No____x_____

If yes, please describe your plans:

21. Changes in Outcome, Impact and Effectiveness Attributable to the Research Project. Describe the outcome, impact, and effectiveness of the research project by summarizing its impact on the incidence of disease, death from disease, stage of disease at time of diagnosis, or other relevant measures of outcome, impact or effectiveness of the research project. If there were no changes, insert "None"; do not use "Not applicable." Responses must be single-spaced below, and no smaller than 12-point type. DO NOT DELETE THESE INSTRUCTIONS. There is no limit to the length of your response.

None

22. Major Discoveries, New Drugs, and New Approaches for Prevention Diagnosis and Treatment. Describe major discoveries, new drugs, and new approaches for prevention, diagnosis and treatment that are attributable to the completed research project. If there were no major discoveries, drugs or approaches, insert "None"; do not use "Not applicable." Responses must be single-spaced below, and no smaller than 12-point type. DO NOT DELETE THESE INSTRUCTIONS. There is no limit to the length of your response.

This project developed a novel, low cost microfabricated poly(methyl methacrylate) (PMMA) Quantum-dot-Linked-ImmunoSorbent-Assay (QLISA) biosensor with embedded mixing elements. The significant advantages of this microfluidic platform with integrated electrokinetic mixing are: *a)* Higher optical detection sensitivity *b)* Improved detection limit *c)* Higher signal to noise ratio *d)* Reduction of assay *e)* Multiuse system - repeated use of the sensor is possible, and *f)* Platform technology – can be used to detect any biomarker. The bioassay platform developed will use only 1-2 microliters of sample and achieve detection sensitivity of picomolar quantities of antigen.

23. Inventions, Patents and Commercial Development Opportunities.

23(A) Were any inventions, which may be patentable or otherwise protectable under Title 35 of the United States Code, conceived or first actually reduced to practice in the performance of work under this health research grant? Yes_____ No___x_____

If "Yes" to 23(A), complete items a – g below for each invention. (Do NOT complete items a - g if 23(A) is "No.")

a. Title of Invention:

b. Name of Inventor(s):

c. Technical Description of Invention (describe nature, purpose, operation and physical, chemical, biological or electrical characteristics of the invention):

d. Was a patent filed for the invention conceived or first actually reduced to practice in the performance of work under this health research grant?
Yes_____ No____

If yes, indicate date patent was filed:

e. Was a patent issued for the invention conceived or first actually reduced to practice in the performance of work under this health research grant?
Yes_____ No____
If yes, indicate number of patent, title and date issued:
Patent number:
Title of patent:
Date issued:

f. Were any licenses granted for the patent obtained as a result of work performed under this health research grant? Yes_____ No____

If yes, how many licenses were granted?_____

g. Were any commercial development activities taken to develop the invention into a commercial product or service for manufacture or sale? Yes___ No____

If yes, describe the commercial development activities:

23(B) Based on the results of this project, are you planning to file for any licenses or patents, or undertake any commercial development opportunities in the future?

Yes_____ No_____x_____

If yes, please describe your plans:

24. Key Investigator Qualifications. Briefly describe the education, research interests and experience and professional commitments of the Principal Investigator and all other key investigators. In place of narrative you may insert the NIH biosketch form here; however, please limit each biosketch to 1-2 pages. *For Nonformula grants only – include information for only those key investigators whose biosketches were not included in the original grant application.*

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

NAME	POSITION TITLE
Elisabeth S. Papazoglou	Associate Professor School of Biomedical Engineering Drexel University
eRA COMMONS USER NAME (credential, e.g., agency login)	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	MM/YY	FIELD OF STUDY
Aristotelian University, Thessaloniki, Greece	B.Sc.	1982	Chemical Engineering
University of Delaware	M.Sc.	1984	Chemical Engineering
Case Western Reserve University, Cleveland, Ohio	Ph.D.	1988	Macromolecular Science / Polymer Engineering
Case Western Reserve University, Cleveland, Ohio	Postdoctoral	1989	Macromolecular Science / Polymer Engineering
Purdue University	Graduate	2000-2002	Biochemistry / Drug Delivery

A. Positions

9/1982-3/1984	Graduate Research Assistant, Department of Chemical Engineering University of Delaware, Newark, DE. Thesis Advisor: Prof. T.W.F. Russell.
4/1984-9/1988	Research Assistant,/Research Associate, Dept. of Macromolecular Sci.&Polymer Engineering, Case Western Reserve University, Cleveland, Ohio. Thesis Advisor: Prof. Robert Simha.
2/1987-7/1987	Visiting Scientist, DSM Central Research, Geleen, The Netherlands.
10/1998-5/1990	Senior R&D Engineer, Arco Chemical Company, Newtown Square, PA
6/1990-10/1992	Principal R&D Engineer, Arco Chemical Company, Newtown Square, PA
11/1992-3/1995	Senior Research Associate, FMC Corporation, Princeton, New Jersey.
4/1995-12/1997	Group Leader, FMC Corporation, Princeton, New Jersey.
1/1998-11/1999	Technology Manager, R&D, FMC Corporation, Princeton, New Jersey.
12/1999-8/2003	Technical Manager, Polymer Additives, Great Lakes, W. Lafayette, Indiana.
9/2003-5/2005	Research Associate Professor, School of Biomedical Engineering, Drexel University,
6/2005- 8/2011	Assistant Professor, School of Biomedical Engineering, Drexel University, Phila, PA
6/2005- 8/2011	Associate Professor, School of Biomedical Engineering, Drexel University, Phila, PA

Publications (selected)

1. S. Babu, S. Mohapatra, L. Zubkov, S. Murthy, **E. Papazoglou**, "A PMMA Microcapillary Quantum dot Linked ImmunoSorbent Assay (QLISA)" to Biosensors and Bioelectronics, Vol. 24, Issue 12, Pages 3467-3474, August 2009.
2. **E. Papazoglou**, MS Weingarten, L Zubkov, M Neidrauer, L Zhu, S Tyagi, K Pourrezaei. "Changes in optical properties of tissue during acute wound healing", *J. of Biomedical Optics*, vol. 13, p. 044005, 2008.
3. MS Weingarten, **E. Papazoglou**, L Zubkov, L Zhu, M Neidrauer, G Savir, K Peace, K. Pourrezaei, K Pourrezaei, "Correlation of Near Infrared Absorption (fNIR) and Diffuse Reflectance Spectroscopy Scattering (DRS) with Tissue Neovascularization and Collagen Concentration in a Diabetic Rat Wound Healing Model". *Wound Repair and Regeneration*, 2008 Mar-April: 16, 234:242
4. S. Babu, C. Fan, C. Sunkari, L. Stepanskiy, J. Uitto, and **E. Papazoglou;** "Effect of size at the nanoscale and bilayer rigidity on skin diffusion of liposomes" Journal of Biomedical Materials Research A, 2008 Sep 3. [Epub ahead of print].
5. V. Kamat, J. Donaldson, C. Kari, M. Quadros, P. Lelkes, I. Chaiken, S. Cocklin, J. Williams, **E. Papazoglou**, U. Rodeck. "Enhanced EGFR inhibition and distinct epitope recognition by EGFR antagonistic mAbs C225 and 425" Canc Biol Ther, 7(5), May 2008.
6. A. Karwa, **E. Papazoglou**, K. Pourrezai, S. Tyagi, S. Murthy "Quantification of Inflammation with Quantum Dots in an animal model of collitis", Inflammation Research,. 56(12), 502-510, Dec.2007.
7. S.B. Nadarajan, P.D. Katsikis and **E. Papazoglou**; "Loading carbon nanotubes with viscous fluids and nanoparticles – a simpler approach" Appl. Phys. A 89, 437–442 (2007).
8. **E. S. Papazoglou** and A. Parasarathry, "Bionanotechnology: A Primer", Morgan and Claypool publishers, March 2007.
9. **E. Papazoglou**, M.S Weingarten, L. Zubkov L, L. Zhu, S. Tyagi, K. Pourezaei, "Near infrared diffuse optical tomography: improving the quality of care in chronic wounds of patients with diabetes." *Biomed Instrum Technol*. 2007 Jan-Feb;41(1):83-7.
10. **E. Papazoglou**, L. Zubkov, M. Weingarten, L. Zhu, S. Tyagi, K. Pourrezaei, "Optical Properties of Wound Tissue in Diabetic and Healthy Animals", IEEE Trans. Biomed. Eng., 53(6), 1047-1055, 2006.
11. M. Weingarten, **E. Papazoglou**, L. Zubkov, L. Zhu, K. Pourrezaei, G. Vorona, A. Walchak "Measurement of optical properties to quantify healing of chronic diabetic wounds", Wound Repair and Regeneration, 14, 364, May-June 2006.
12. A. Kriete, **E. Papazoglou**, B. Edrissi, H. Pais, K. Pourrezaei, "Automated Quantification of Q-dot Labeled EGFr Internalization via Multi-Scale Image Segmentation", Journal of Microscopy, 222(1), 22-27, April 2006.
13. Sreekant Murthy, **E. Papazoglou**, Nandhakumar Kanagarajan and Narasim S. Murthy, "Nanotechnology: Towards the detection and treatment of inflammatory diseases", Chapter in In Vivo Models of Inflammation, Stevenson, Christopher. S.; Marshall, Lisa A.; Morgan, Douglas W. (Eds.), 2006.
14. M. R. Contarino, V. Kamat, E. Keough, N. S., Babu, **E. Papazoglou**, I. M. Chaiken, S.D. Tyagi, K.