DEFN-14-19220

PROJECT DEFINITION

APPROVALS

ROLE	NAME	SIGNATURE	DATE
Team Leader	Lydia Ameri		
Advisor	Dr. Lawrence Kulinsky		
Advisor	Dr. William Tang		

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CD Fluidics

This document was created from template SDP-120. Contact the Mechanical and Aerospace department at the University of California, Irvine for more details.

Revision History

REV	DESCRIPTION	DATE	APPROVED BY
-	Initial Release	*[mm/dd/yy]*	*[an approver]*
[A]	Trapezoidal and Rectangular electrode designs – Version 1	1/19/2015	*LA*
B	Trapezoidal and Rectangular electrode designs – Version 2	1/30/2015	*LA*
C	Trapezoidal and Rectangular electrode designs – Version 3	2/1/2015	*LA*
D	Trapezoidal and Rectangular electrode designs – Version 4	2/2/2015	*LA*
E	Trapezoidal and Rectangular electrode designs – Version 5	2/3/2015	*LA*

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1 PROJECT OVERVIEW

1.1 Executive Summary

Recently, there has been a surging interest in cells known as cancer stem cells (CSCs). These cells are said to behave very similarly to normal stem cells in that they have the capability to self-renew and differentiate into more specialized cell types. In the case of the CSCs, they are capable of reproducing themselves and ultimately sustaining a cancer when they differentiate into the more commonly known tumor cells. The theory behind CSCs has immense implications. Currently, no cure for cancer exists but various cancer treatments and therapies do exist. These typically involve surgery, immune therapy, targeted therapy, hormone therapy, or chemotherapy. Many of these treatments focus heavily on killing rapidly dividing and growing cells, which is a characteristic of most cancer cells. However, with the introduction of CSCs, these treatments are generally rendered ineffective as they do not target the slower dividing CSCs. As such, CSCs can potentially cause a relapse after treatment even after all observable signs of cancer have been eliminated. Thus, our research team aspires to isolate these rare CSCs from normal rapidly dividing cancer cells in order to study them further. We believe that the study of CSCs may lead to a paradigm shift in the cancer field and may allow researchers to ultimately understand and target cancer at its core.

The function of the microfluidic device will be to separate the CSCs from other (non-tumorigenic) cancer cells by utilizing differences in polarizability between different cell types. In living cells, electrically charged ions are exchanged across the cell membrane. Previous research has proven that cells that are tumorigenic exhibit higher membrane capacitance than non-tumorigenic (i.e. regular) cancer cells. Through dielectrophoresis (DEP), this microfluidic device will separate the CSCs from the cancer cells by creating a non-uniform electric field within a network of interdigitated electrodes, as shown in Figure 2. Positive DEP forces will cause the CSCs to move towards the electrodes with the highest field concentration, and while CSC cells are retained within the electrode network, other cells can be washed out of the system. Two different designs will be tested. One design will use the material polydimethylsiloxane (PDMS) to create the channels which the fluid will run through and the other design will use CNC machined plastic.

2 PROJECT DETAIL

2.1 Project Objective(s)

Objective 1 – Separate at least 90% of CSCs from non-tumorigenic cancer cells.
Through DEP, a strong non-uniform electric field should be created to separate tumorigenic cells from non-tumorigenic cancer cells based on their membrane capacitance.

Objective 2 – Separate the cancer cells based on temporal separation.
A velocity profile should be created due to the electric field and densities of the cells as they flow through the channels. After some time, the regular cells will be captured from the outlet. The function generator will then be released to capture the remaining cells, which should theoretically be the CSCs.

Objective 3 – Determine which prototype design will provide the best results and have no leakages.
Two designs will be created and tested to determine which would allow the fluid to run through the channels. Previous attempts in bonding PDMS to glass has shown that when fluid is run through, it leaks through the device. Bonding two layers of PDMS together should resolve this issue. This has been tested and one device showed leakage, which was expected since it was observed that it was not bonded well. The other device flowed through the channels without leaking. Therefore, it may work. Should it not work, the CNC machined device will be tested.

2.2 Scope Details

It is expected that by the end of winter quarter both prototypes will be fabricated and tested using polystyrene beads.

2.3 Project Milestones

Milestone Name	Target Date	Comments
Create Electrode Mask	1/21/15	The mask design was completed on 2/4/15
Build Plasma bonding prototype	2/17/15	
Build CNC machined plastic prototype	2/18/15	
Test PDMS prototype with polystyrene beads	2/23/15	
Test plastic prototype with polystyrene beads	2/25/15	
Test best prototype with real blood sample	TBD	Preferably done within week 2 or 3 of Spring Quarter

2.4 Project Team

#	Name	Project Role	Email	Phone	Standing	Units
1	Lydia Ameri	Team Leader	lameri@uci.edu	(858) 349-7772	Senior	1
2	Gema Veragon	Researcher	gveragon@uci.edu		Senior	

2.5 Steering Team

#	Name	Title	Steering Role	Email	Phone
1	Dr. Lawrence Kulinsky	Professor	Advisor		

2	Dr. William Tang	Professor	Advisor		

2.6 Project Costs Estimation

Project Expense	Comments	Est. Amount ($)
Electrode Mask		$100
Cleanroom facilities		$200
Beads		$50
	Total	*$350*

2.7 Resource Estimation

Name	Est. Hours	Rate ($/hr)	Est. Total ($)
Lydia Ameri	5	0	0
Gema Veragon	5	0	0
Total	*10*		*0*

3 Project Risks and Communication

3.1 Risk Mitigation Plan

Risk	Severity	Probability	Mitigation
Clean room down	Medium	Medium	Create as many devices in the beginning
Mask incorrectly made	High	Medium	Create a new device as soon as a problem with the current design has been identified.
Function generator not working	Low	Low	Use another function generator from a different lab.
Plasma bonding machine down	High	Low	Cancel that idea as a prototype and work on the CNC machined design.

Communication Plan

Communication Type	Audience	Frequency	Responsibility
Weekly Meetings	Dr. Tang, Gema, Lydia	Every Wednesday 11:00am	Dr. Tang
Email	everyone	Once a week	Dr. Kulinsky and Lydia
Phone	Lydia, Gema	Once a week	Lydia and Gema

4 Additional Project Details