IOWA STATE UNIVERSITY
Department of Chemistry

University Honors Program
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Anne Wallace, Advised by Robbyn Anand

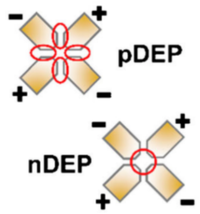
Gel entrapment of tumor cell clusters patterned by dielectrophoresis (DEP) at a bipolar electrode array

Introduction

Background: It is difficult to separate cancers cells from healthy cells in our bodies. Therefore, within the field of medicine, there is a need for gel entrapment of tumor cell clusters using dielectrophoresis (DEP) at wireless bipolar electrodes (BPEs). The advancement of using a gelatin as the medium for cells will further therapeutic and diagnostic research.

Objective: Research and develop a gel that allows cell movement when the AC electric field is on, but halts cell movement when the current is absent allowing for isolation of cells.

Dielectrophoresis (DEP): subjects' dielectric particles to an electric field, allowing a force to be exerted on those particles



Bipolar Electrode (BPE): electronic conductor in contact with an ionically conductive phase

Research & Development

Research → **Application** → **Process**

DEP allows for cell separation and isolation while the gel allows for cell capture.

Perform DEP on cells within a gel environment to obtain a potential method for further analysis of cancer cells.

Synthesize a gel with similar properties to the traditional environment of cells using two different methods.

Materials & Methods

1 Cell Culture

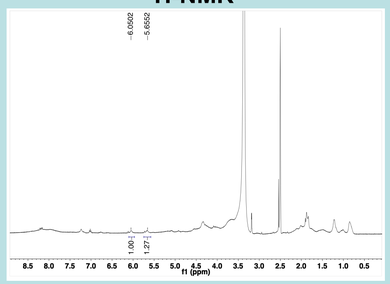
MDA-MB-231 Cells → Rinse with Trypsin-EDTA Solution → Add Trypsin-EDTA Solution → Incubate 5 Minutes → Centrifuge Down Pellets → Resuspend in TRIS DEP Buffer → Add Culture Medium → Centrifuge Down Pellets

2 Process Methods

Method 1

Gel Synthesis
- Powder gelatin, glycidyl methacrylate, and 4-methylaminopyridine dissolved in dimethyl sulfoxide
- Mixture was stirred and dialyzed with deionized water
- Lyophilization was used to obtain the gel

H-NMR

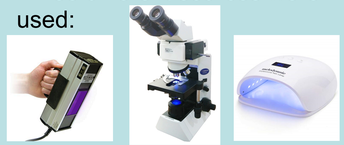


DEP and Conductivity
- DEP was performed to isolate cells and conductivity was measured

Method 2

Gel Synthesis
- Gel-MA in DEP Buffer solution consisted of sucrose, dextrose, BSA, Tris, and Irgacure 2959
- Three concentrations made: 0.01%, 0.1%, and 1.0%

UV Cross Link
- UV light will induce a reaction and create a gel consistency
- Three different sources were used:

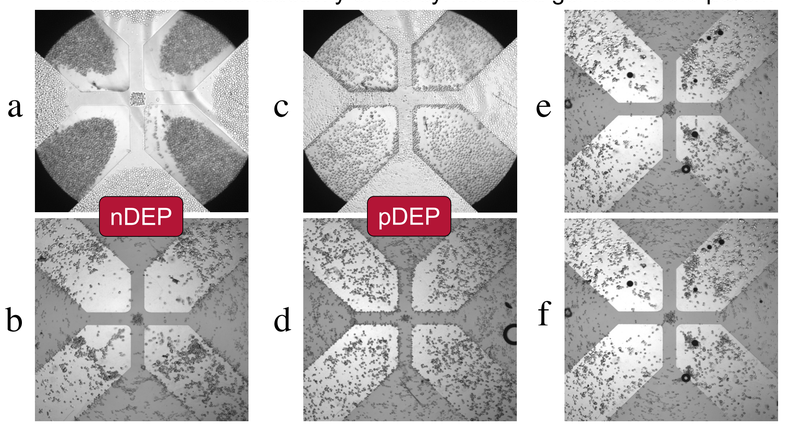


- Gel-MA solution was pipetted on a microscope slide and exposed to UV light for 30s, 60s, 90s, and 6 minutes

Conductivity
- Conductivity was measured with and without tris at the three concentrations

Results & Conclusions

1
- H-NMR results were inconclusive
- The measured conductivity of the synthesized gel was 460.0 µS/cm



Future: Further experiments are to synthesize the gel again and try to obtain a lower conductivity level, as well as a better NMR.

2
- All sources of UV light did not seem to allow cross-linking of the Gel-MA solution

Concentration (%)	Conductivity (µS/cm)	Tris Present?
0.01	93.26	✓
0.1	100.2	✓
1.0	117.1	✓
0.01	29.42	X
0.1	29.16	X
1.0	54.87	X

Future: Further experiments are to find a way to cross-link the Gel-MA solution with UV light. After this is successful, cell response using DEP at a quadropole electrode as a function of AC electric field frequency in the gel precursor will be tested. Finally, cell cluster size at a bipolar electrode (BPE) array will be studied as a function of flow rate, voltage, and BPE length.

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References: Joseph T. Banovetz, Min Li, Darshna Pagariya, Sungu Kim and Robbyn K. Anand. Defining cell cluster size by dielectrophoretic capture at an array of wireless electrodes of several distinct lengths. 2019. ; Jason W. Nichol, Sandeep T. Koshy, Hojae Bae, Chang M. Hwang, Seda Yamanlar, and Ali Khademhosseini. Cell-laden microengineered gelatin methacrylate hydrogels. *Biomaterials*. 2010. ; B. A. Nestor; E. Samiei; R. Samanipour; A. Gupta; A. Van den Berg; M. Diaz de Leon Derby; Z. Wang; H. Rezaei Nejad; K. Kim; M. Hoorfar. Digital microfluidic platform for dielectrophoretic patterning of cells encapsulated in hydrogel droplets. *Royal Society of Chemistry*. RSC Adv., **2016**, 6, 57409. ; Chaenyung Cha; Jonghyun Oh; Keekyoung Kim; Yiling Qiu; Maria Joh; Su Ryon Shin; Xin Wang; Gulden Camci-Unal; Kai-tak Wan; Ronglih Liao; Ali Khademhosseini. Microfluidics-Assisted Fabrication of Gelatin-Silica Core–Shell Microgels for Injectable Tissue Constructs. *Biomacromolecules*. **2014**, 15, 283-290. ; Min Li; Robbyn K. Anand. High-Throughput Selective Capture of Single Circulating Tumor Cells by Dielectrophoresis at a Wireless Electrode Array. *J. Am. Chem. Soc*., **2017**, *139* (26), pp 8950–8959. ; Velev, O. D.; Gangwal, S.; Petsev, D. N. Annu. Rep. Prog. Chem., Sect. C: Phys. Chem. **2009**, 105, 213. ; Velev, O. D.; Bhatt, K. H. Soft Matter **2006**, 2, 738.