Application to Graduate with Honors

Student ID: [redacted]

I plan to defend ... FALL (SPRING) of 2011

Personal Information:

Name: Tyler Wingfield

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I am an: (IN-STATE) / OUT-OF-STATE student

Academic Information:

☑ I plan to graduate with *Departmental Honors* in: Physics

☐ I plan to graduate with *General Honors*

Cumulative GPA:

Please attach a brief **PROSPECTUS**, **BIBLIOGRAPHY**, and **TIMELINE** of your thesis project to this application. When summarizing your work, consider the following:

- What is the problem you are investigating?
- What is the hypothesis you are testing?
- What is the focus of your study?
- What is your goal in this study?

Primary thesis advisor: Name: Ivan Smalyukh Dept: Physics

List the other members of your committee:
Name: Scot Douglass Dept: Herbst Humanities
Name: John Cumalat Dept: Physics
Name: _____ Dept: _____
Name: _____ Dept: _____

Departmental and General Honors Committee Checklist:

Applicant has a total of at least three committee members.
At least one Honors Council Representative is included on committee.
At least one committee member from an outside department.

APPLICATION CONTINUED ON BACK OF THIS SHEET

Please initial if you are pursuing Departmental Honors:

TBW I have consulted with my department and have completed (or am completing) the requirements they have established.

For Honors Council Representative:

I have met with applicant and approve him/her for departmental honors.

Printed Name: John Cumalat Signature: _____

Please initial if you are pursuing General Honors:

_____ I have completed (or am completing) the requirements for graduating with General Honors.
Please list the courses you have or are taking toward General Honors:

_____ _____

_____ _____

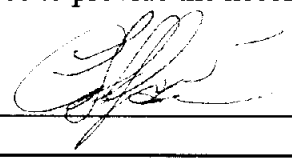
For General Honors Council Member:

I have met with applicant and approve him/her for general honors. I agree to be on his/her defense committee.

Printed Name: _____ Signature: _____

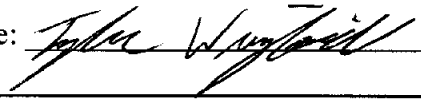
For the Thesis Advisor:

I have met with the applicant to discuss the proposed work and agree to provide the necessary help and direction for this thesis project.

Printed Name: IVAN SMALYUKH Signature: 

For the Student:

I have read the requirements for graduating with honors at the University of Colorado. I also understand that my designation will be sent to the CU email address that I have provided and will not be given out over the phone.

Signature:  Date: 12/1/10

For additional graduation information including requirements, guidelines and deadlines, you can download them online at www.colorado.edu/honors

In Plane Switching of Nematic Phase Liquid Crystal E31 Utilizing Carbon Fiber Electrodes

Tyler Wingfield
Advisor: Ivan Smalyukh

Background:

Current in plane switching liquid crystal displays (LCDs) such as digital watches and pocket calculators, as well as many other LCDs, depend on Indium Tin Oxide as the electrode to switch the orientation of the liquid crystal director in displays, thereby changing greenish bronze (background color of calculators) to black, producing an image. Because Indium Tin Oxide is a costly inorganic material that is in limited supply, researchers in academia and industry alike are pursuing many alternative possibilities to not only replace Indium Tin Oxide, but to reduce the price of LCDs and expand their capabilities. Materials being investigated include conductive epoxies, graphene, and carbon nanotubes.

Carbon nanotubes exhibit extraordinary conductivity when analyzed individually and useful conductivity in bulk assemblies such as fibers. Collaborators at Rice University have developed a simple method to produce carbon fibers by wet spinning from high concentration carbon nanotube and super acid solutions. These fibers exhibit high degrees of nanotube alignment and resisitivity of 0.2 mΩcm.

Rice University has also produced highly aligned carbon nanotube carpets. These carpets consist of large numbers of homeotropically grown carbon fibers. I have performed previous research on the self-alignment of plasmonic gold nanorods in these carpets and carbon fibers. Plasmonic gold nanorods have been the subject of intense research due to their very interesting optoelectronic properties. Gold nanorods have applications in sensing techniques in the realm of biology and medicine, as well as the potential to form metamaterials from bulk alignment and organization. Julian Evans, a graduate student in our lab, has developed methods for thiol capping these gold nanorods to support dispersions in thermotropic liquid crystals.

Goal:

The project goal is to produce and characterize an in plane switching LCD pixel using carbon fiber electrodes and E31 in a nematic phase with both homeotropic and planar alignment. E31 is a thermotropic liquid crystal enabling director switching at low voltages (~1V). I intend to analyze and characterize the dielectrophoric effects and self-alignment of gold nanorods in this thermotropic nematic liquid crystal. This configuration will enable low voltage, low current switching of a LCD constructed with abundant and relatively inexpensive electrodes, as well as ordering and active realignment of plasmonic gold nanorods enabling switchable polarization dependant plasmon resonance.

This research will not only develop new methods of LCD technology, but also expand the experimental applications of gold nanorods.

Progress:

Currently, I have produced a homeotropically aligned liquid crystal cell exhibiting the expected switching. I am in the process of characterizing this cell, as well as building similar cells and acquiring new carbon fibers of varying diameter to characterize the switching time of the director of the liquid crystal.

BIBLIOGRAPHY

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Alan Windle. "Processing: Superacids offer nanotube solution". *Nature Nanotechnology* 4, 800 - 801 (2009)

Virginia A. Davis, A. Nicholas G. Parra-Vasquez, Micah J. Green, Pradeep K. Rai, Natnael Behabtu, Valentin Prieto, Richard D. Booker, Judith Schmidt, Ellina Kesselman, Wei Zhou, Hua Fan, W. Wade Adams, Robert H. Hauge, John E. Fischer, Yachin Cohen, Yeshayahu Talmon, Richard E. Smalley & Matteo Pasquali. "True solutions of single-walled carbon nanotubes for assembly into macroscopic materials". *Nature Nanotechnology* 4, 830 - 834 (2009).

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TIMELINE

December: Characterize switching time, voltage, and thickness of current homeotropically aligned cell. Build duplicate cell. Assemble planar aligned cell and begin to characterize.

January: Experiment with surfactant coatings to produce defect line along the carbon fiber electrode in a homeotropically aligned cell to measure director alignments below the threshold switching voltage.

February and March: Introduce gold nanorods into cell to analyze and characterize self-alignment and dielectrophoresis effects.

End of March and April: Wrap up experiments. Begin writing thesis as well as compiling lab work for publications.