# POSTER PROGRAM – PCAMM Annual Meeting
# Friday, December 5th 2014 at the University of Victoria

## Poster 1. Neuronal Differentiation of Human Induced Pluripotent Stem Cells Seeded on Melt Electrospun Microfiber

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Human induced pluripotent stem cells (iPSCs) were first derived from human fibroblasts by the Nobel Prize winner Yamanaka and his colleagues. Human iPSCs have two prominent properties: pluripotency and the ability to self-renew. Human iPSCs are an alternative to human embryonic stem cells (ESCs) since reprogramming adult cells can be used to for producing patient specific cell lines and avoids the bioethical issues related to human ESCs. One of the major challenges when differentiating human iPSCs is how to control this process to produce the desired cell phenotypes. To obtain mature neurons, iPSCs can be treated with chemical cues such as growth factors and also physical cues to stimulate the differentiation of stem cells into neurons. In this work, we investigate how the architecture of melt electrospun scaffolds influences the differentiation of human iPSCs into neurons and their resulting alignment. This combination of human iPSC-dervied neurons seeded on such electrospun scaffolds could be used for neural tissue engineering applications.

## Poster 2. Electronic Properties of Metal-molecular Junctions and Networks

**P. Zhang** and C. Papadopoulos
*ECE Department, University of Victoria, Victoria, BC*

Electronics based on individual molecules is often considered the ultimate form of miniaturization for future "beyond CMOS" technologies and hybrid integrated circuits. Molecules attached to metallic electrodes typically form the basic structure of molecular electronic devices. Here, we extend this concept to nanoscale networks consisting of multiple metal-molecule junctions. Semi-empirical MO calculations (AM1 or PM3) will be presented for molecules interconnected with small metallic clusters. HOMO-LUMO gaps, spatial distribution and potentials are examined for electronic transport and novel device functionalities. The spatial distribution of the molecular orbitals show delocalization features indicating contribution to electronic transport along such structures.

## Poster 3. Capabilities of the UBC AMPEL Nanofabrication Facility

**Mario Beaudoin**
*University of British Columbia*

The AMPEL Nanofabrication Facility (ANF) is the center for device fabrication at UBC for multidisciplinary applications including microfabrication of microfluidics devices (for proteomics, DNA sequencing, lab-on-chip, cell cultures), photonics (photonic crystals, lasers, modulators), and nano-electronics (carbon nanotube devices, graphene electronics) as well as several other endeavors. The facility is used by research groups from the faculties of Applied Science, Science and Dentistry, as well as off-campus academic and industrial users. The Nanofabrication Facility is a cleanroom laboratory situated on the fourth floor of the AMPEL building on the UBC campus. It is a fee-based laboratory open to UBC and outside users, as a service, or for trained users. As a service laboratory in Vancouver, our experienced process staff are available to perform fabrication tasks ranging from single steps to full device fabrication. This poster presentation is intended to both showcase some of our capabilities and to explain how the lab can be accessed by academic and industry users.

## Poster 4. Compressive Fabrics to Assist Blood Flow

**Ali Rafie Ravandi**, Soheil Kianzad, Seyed M Mirvakili, Walter Hardy, John D.W Madden
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As the result of blood clot formation in veins, drainage can be blocked which leads to swelling of body parts. This condition is called edema. Also, venous return of the blood in the legs, which is reliant on the movement and contraction of adjacent muscles, driving flow through one-way valves, can be disturbed by clotting. A common treatment of patients with these conditions involves the facilitation of blood flow by periodically squeezing and releasing the swollen regions. Currently to treat patients with this condition, known as deep venous thrombosis (DVT) doctors are using a medical appliance known as an intermittent pneumatic compression sleeve. As an inexpensive alternative to these systems, we have developed an active fabric using nylon actuators which we propose to use to apply force and squeeze the veins locally to accelerate the blood flow, and prevent the formation of blood clots. The crystalline structure in this polymer actuator leads helical coils to contract as it is heated. These actuators can be activated all at once or in sequence to enhance the blood movement.

## Poster 5. Multimodal Microscopy of Almost Nothing - 30mg/cc Aerogels

Dr. Elaine Humphrey and **Prof. George Beer**
*University of Victoria*

Low-density aerogel sheets have been studied for production of cold muonium (Positive muon and orbiting electron) at TRIUMF and at J-PARC in Japan both for use in a proposed measurement of the muon g-2 and as a source of very low energy positive muons used in thin-film MuSR. The yield of surface muonium was inadequate from aerogel sheets of varying

densities but the yield was significantly increased by “ablating” holes in the surface. This process resulted in an unexplained loss of aerogel mass which has not yet been understood.
At UVic’s Advanced Microscopy Facility, a typical bulk target was studied with an optical microscope, a confocal microscope and the STEHM and, as well, the surfaces of uncoated aerogels were imaged in 3D with the SEM.

## Poster 6. Optical Trapping and Diagnostic Analysis of ~ 20 nm Gold Nanoparticles Using Photonic Crystal Slot Microcavity

**Seyed Hamed Mirsadeghi**
*University of British Columbia*

Dipolar coupling of light and small particles results in optical forces being exerted on the particles in the presence of strong gradients in light intensity. In photonic crystal cavities, this gradient force is significantly enhanced as compared to conventional laser tweezers, due to their large light confinement (small mode volume). Here, we report our recent advances in using silicon-on-insulator (SOI) photonic integrated circuits for trapping gold nanoparticles (both spheres and rods) of sizes as small as 20 nm, with sub-mW laser powers. The photonic circuits are formed of a pair of grating couplers, various coupling waveguides and a photonic crystal slot cavity.

We demonstrate that this device can be utilized to estimate the size distribution of the particles in solution.

## Poster 7. Study of CdSe quantum dots and its application in solar cells

**José Augusto Lucena dos Santos**
*Federal University of Rio Grande do Sul*

In this work we present the study of CdSe quantum dots (QDs), since of its synthesis, surface modification, characterization, and application for sensitizing $TiO_2$. The QDs were synthesized by method of injecting hot precursor Se-Trioctylphosphine (TOP) in a solution of oleic acid (OA) and cadmium acetate dihydrate in octadecene. Through the obtained Transmission Electron Microscopy (TEM) images, the QDs present nearly spherical shape with an average diameter of 4nm and small size distribution, which is in agreement with the UV-Vis absorption spectra presenting a narrow absorption band with maximum at ca. 598nm. The QDs stabilized with OA were modified with two different ligands, 3-mercaptopropionic acid (MPA) and 4-mercaptobenzoic acid (MBA), to evaluate how the surface modification can affect the QD adsorption on $TiO_2$ and the electron transfer at the interface, therefore affecting the efficiency of the solar cells. It was monitored by checking changes in solubility and a small red-shift of the emission band. A considerable improvement in the quantity of loaded QDs was observed for using OA by EDS mapping and absorption spectra. This result is interesting once an increased amount of sensitizer loaded on the $TiO_2$ surface should lead to enhanced photocurrent. We have observed samples obtained with OA presented slightly higher efficiency by IxV curves.

## Poster 8. Characterization of Transport Properties of Catalyst Layer of a PEMFC

**Sina Salari**, Claire McCague, Mohammad Ahadi, Mickey Tam*, Ehsan Sadeghi*, Jürgen Stumper, and Majid Bahrami
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Polymer electrolyte membrane fuel cells (PEMFC) rely on a membrane-electrode assembly (MEA) constructed from multiple layers of micro/nano porous materials and associated interfaces. The MEA includes a polymer electrolyte membrane (PEM) that conducts protons, a composite nano-structured catalyst layer (CL), and a fibrous gas diffusion layer (GDL) that distributes reactant gases and collects current. Transport properties of CL are among the key parameters affecting performance of a PEMFC. Reactants reach Pt particles in the CL through a gas diffusion mechanism, and heat is dissipated from the CL mostly through conduction. As a result, deep understanding of transport properties of CL is a necessity to design PEMFC. Because of the complex geometry of CL, the existing models for transport properties with good accuracy are computationally demanding. Also, current measurement methods have high uncertainties as CL layer is a very thin layer (several microns) which is coated on a thicker substrate. The lack of accurate models and reliable measurement data for heat and mass transfer through CL has motivated this research collaboration between SFU's *Laboratory for Alternative Energy Conversion* (LAEC) and the *Automotive Fuel Cell Corporation* (AFCC).
A unit cell approach is being utilized to model conduction and diffusion through the catalyst layer of carbon-supported platinum agglomerates coated with ionomer. The diffusion problems are solved analytically for the unit cell and effective properties are modeled. Experimental characterization of catalyst layers prepared at AFCC are underway both to provide parameters utilized by the models and to verify results. Structural properties are determined by porosimetry and SEM imaging. Thermal conductivity, thermal diffusivity and contact resistance are measured with a guarded hot-plate apparatus and a transient plane source 'hot disk' thermal analyzer. A custom-built dry diffusivity test apparatus and a modified Loschmidt cell test bed will be used to study the of diffusivity of the CL and supportive substrates.

## Poster 9. Development SU-8 Based Neural Probes

**J. A. B. Guevara***, A. H. A. Malavazi*, R. R. Panepucci**, R. J. M. Covolan*, A. G. Brolo***
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Neural probes are a type of invasive technology able to perform both to record and stimulate groups of neuronal cells in vivo (within the body) and in vitro (outside of the body). We fabricated Polymer-based neural probes with planar microelectrodes, using microfabrication technology for production of a SU-8 polymer based probe, chosen as structural material due to its good electromechanical properties, and biocompatibility. A parametric design methodology was produced in order to easily change the probe's geometry according to future specifications. Besides, a simple and low-cost fabrication process successfully produced narrow, flexible and thin devices specifically designed to minimize tissue damage during insertion in brain tissue.

**Poster 10. Increasing the Photocatalytic Properties of TiO2 NTs with Deposition of Noble Metal by Sputtering Technique**

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In this work, we present the results obtained from the synthesis and characterization of TiO2 nanotubes decorated with platinum nanoparticles (Pt/Nt-TiO2) as well as its application in phototocatalysis cells used to produce hydrogen (H2). The primary step of this work was the synthesis and characterization of the TiO2 nanotubes. The TiO2 nanotubes were obtained with 1 um of length and amorphous phase as anodized. After anodization all samples were submitted thermally treated under air to verifying the influence of temperature and period of annealing. The sample annealed at 400°C during 3 hours presented the biggest hydrogen production. The second part of this work concerned the use of DC Magnetron Sputtering to deposit Pt nanoparticles on the TiO2 nanotubes annealed at 400°C during 3 hours. The photocatalytics results an increased in 3 times fold after deposition of Pt. The samples with and without Pt were characterized by MEV, EDS, TEM and XRD. Photogeneration of hydrogen by water splitting was carried using a double wall quartz photochemical reactor and as excitation source was used a 240 W Hg−Xe lamp (Cermax). The gaseous products of the photocatalytic reaction were quantified by gas chromatography. The results obtained in this work demonstrate the influence of thermal annealing in crystallization and photocalytics properties of TiO2 nanotubes and the effect of deposition of Pt on TiO2 nanotubes in production of hydrogen. According to the results, we conclude that TiO2 nanotubes annealed at 400°C during 3 hours under air decorated with Pt nanoparticles developed in this work presents potential for hydrogen generation.

**Poster 11. Interface Vibrational Sum Frequency Generation Spectroscopy with Multiple Infrared Pulses: A method to Enable Vibrational Lifetime, Photon Echo, and 2D Spectroscopy Measurements.**

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*4D LABS, Simon Fraser University*

Sum-frequency generation (SFG) vibrational spectroscopy is a powerful tool in surface science, providing infrared transition frequencies and line shapes to probe the structure of molecules at interfaces. Here we describe a simple and useful method of increasing the number of infrared pulses and controlling their relative time delay using a passive, birefringence-based method in a collinear geometry, designed to mitigate phase instability. The resulting pulses can be used to probe interface dynamics by vibrational lifetime and photon echo methods. Additional infrared pulses can be employed to achieve heterodyne-detected two dimensional SFG spectroscopy with phase sensitive detection.

**Poster 12. Controlled Release of Glial Cell-Derived Neurotophic Factor from Biodegradable Poly (Ɛ-Caprolactone) Microspheres**

**Andrew Agbay**[1], Nima Khadem Mohtaram[2], Stephanie M. Willerth[2, 3]
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Glial cell-derived neurotrophic factor (GDNF) promotes the survival of dopaminergic neurons, and as a result, it is currently being evaluated in clinical trials to determine if such a therapy enhances recovery in patients suffering from Parkinson's disease (PD) [1]. These studies involve GDNF delivery from implanted catheters inside of the brain, which can lead to infection as other negative side effects. This work investigates how to deliver bioactive GDNF from microspheres over an extended time course with the end goal of developing a suitable, clinically relevant formulation for injection to the appropriate regions of the brain for the treatment of PD.

**Poster 13. Coaxial GaAs Nanowire Tunnel Diodes**

**A. Darbandi**, K. Kavanagh, and S. P. Watkins
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Semiconductor nanowires (NWs) are promising candidates for various devices, including photovoltaics, tunnel field effect transistors, and light emitting diodes. In this work we present our recent progress in the growth and electrical characterization of single NW n-p core-shell structures grown by the vapor-liquid-solid (VLS) growth mechanism using gold nanoparticles as a catalyst. The major challenges are: doping of the NWs, passivation of surfaces in III-V materials, Ohmic contact formation with NWs, and fabrication of isolated core-shell p-n junctions. We explore the use of a nanoprobe method to measure the properties of single core-shell NWs on a conducting substrate, without the use of potentially damaging and expensive lithography. Coaxial junctions with various shell thicknesses and doping levels were studied in order to improve the electrical properties and ideality factors of the fabricated n-p devices. In order to employ the nanoprobe method on core-shell structures, we have developed a novel self-aligned isolation technique using gallium oxide deposition to eliminate the parasitic two dimensional layer that typically occurs at the substrate surface during shell growth. We have demonstrated clear evidence of radial core-shell current transport with ideality factors as low as 2.8 without passivation. In addition, we will present evidence of radial tunneling transport for highly doped p-n core shell structures, as evidenced by the observation of negative differential resistance behaviour with peak-valley ratios up to 2.3.

**Poster 14. $Nd^{3+}$-doped Nanoparticles for use in a Nanoparticle Dispersion Laser**

**Stephanie Bonvicini** and Frank C. J. M. van Veggel
*University of Victoria*

In this work, we report on the synthesis and optical properties of $NaGdF_4$:$Y^{3+}$/$Nd^{3+}$ and $LaF_3$:$Nd^{3+}$ nanoparticles for use in the fabrication of a new nanoparticle dispersion laser. The desired nanoparticles should have 5% neodymium, have a diameter of 5 nm or smaller, be dispersible in DMSO, and exhibit lifetimes of greater than 100 μs. Neodymium is chosen as it has a 1064 nm lasing transition. Smaller particles are desirable in order to avoid scattering of the excitation source and amplified light. Finally, longer lifetimes increase the ease with which a population inversion can be established. To date we have made nanoparticles that emit at 1064 nm, however the lifetimes fall short of the desired range.

### Poster 15. Nanorod Surface Plasmon Enhancement of Laser-Induced Ultrafast Demagnetization

**Haitian Xu**[1], Hajisalem Ghazal[2], Geoffrey M. Steeves[1], Byoung-Chul Choi[1], Reuven Gordon[2]
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Ultrafast laser-induced magnetization dynamics in ferromagnetic thin films were measured using a femtosecond Ti:sapphire laser in a pump-probe magneto-optic Kerr effect setup. The effect of plasmon resonance on the transient magnetization was investigated by drop-coating the ferromagnetic films with gold nanorods supporting longitudinal surface plasmon resonance near the laser wavelength. With ~4% nanorod areal coverage, we observe a > 50% increase in demagnetization in nanorod-coated samples at pump fluences on the order of 0.1 mJ/cm2 due to surface plasmon-enhanced localized heat absorption, an effect which becomes more significant at higher fluences.

We were able to qualitatively reproduce the experimental observations using simple model calculations based on mean-field theory. This dramatic enhancement of ultrafast laser-induced demagnetization points to promising applications of nanorod-coated thin films in heat-assisted magnetic recording.

### Poster 16. Synthesis of Poly(Phenylenes)-Poly(Paraphenylene Sulfonic Acid)

**Skalski, Thomas**, Steven Holdcroft
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Sulfonated poly(phenylene)s are an interesting group of hydrocarbon materials for use in proton exchange membrane fuel cells (PEM FCs) because of their high mechanical and thermo-oxidative stability. Usually, polymers are randomly post-functionalized to obtain proton-conducting properties.[1-3] Because randomly-functionalized materials are not ideal as proton conductors, a new synthesis route has been developed in order to obtain well-defined pre-functionalized monomers for polymer synthesis.

### Poster 17. Dependence of $GaAs_{1-x}Bi_x$ Optical Properties on Growth Conditions Specially Temperature of the Growth

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Bismuth containing III-V semiconductors have recently attracted interest, creating prospects for a new class of long wavelength and terahertz devices. Incorporation of Bi in GaAs causes a large reduction of the bandgap, allowing 1 eV bandgaps and beyond to be reached on GaAs with less strain than for In, Sb and N (0.7% mismatch for 1 eV). This property along with the fact that $GaAs_{1-x}Bi_x$ shows strong photoluminescence (PL) indicates that this material has promise for applications in optical devices such as multi-junction solar cells and long wavelength emitters and detectors [1].

PL intensity of GaAsBi depends strongly on growth conditions specially growth temperature. The PL intensity drops ×100 when the growth temperature is decreased from 400 to 325°C. Temperature and power dependent PL of two samples with ~2% Bi incorporation grown at 375 and 330°C were carried out. The 330°C grown sample shows some crystal degradation like its bandgap temperature sensitivity of -0.25 meV/K in the range of 150-300K that is smaller than the 375°C grown sample (-0.35 meV/K) and it has larger defect emission. The separation between the defect and band edge emission found to be a function of temperature and pump intensity: $\Delta E = k_B T \times \ln(I^{\gamma}) + k_B T \times C$.

[1] R.R. King et al., Prog. Photovolt: Res. Appl. 20, (2012).

## Poster 18. Theoretical Determination of the Electric Field-magnetic Field Phase Diagram of Multiferroic BiFeO3

**Marc Allen** and Rogério de Sousa
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The room temperature multiferroic bismuth ferrite (BiFeO3 or BFO) has cycloidal spin order when the externally applied magnetic and electric fields are zero. In this configuration, both ferromagnetic and antiferromagnetic order parameters average out to zero over the period of the cycloid, precluding the design of memory devices. Previous theory has shown that the external B field necessary for converting the cycloid into a homogeneous state with non-zero ferromagnetism is of the order of B=20 Tesla. It is also known that the application of an external electric field of suitable strength and direction will induce homogeneous ordering. Using a novel numerical energy minimization scheme, we have simulated the spin arrangement for bulk BFO at different combinations of fields and determined whether the system is cycloidal or homogeneous. Using our results, we have constructed E-B phase diagrams for BFO. When BFO is subject to moderate E and B fields at appropriate orientations, the competing interactions interfere in such a way that the system transitions into the homogeneous state at lower field values than if only one type of field was applied. These results clarify the conditions required to make BFO a useful material in device applications.

## Poster 19. Initial Measurements of Hole Traps in MBE-grown GaAs and GaAs1-xBix

**M.C. Tarun**[1]**,** R.B. Lewis[2], V. Bahrami-Yekta[2], M. Masnadi-Shirazi[2], T. Tiedje[2], and P.M. Mooney[1]
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GaAs1-xBix alloys are of interest because of the larger reduction of the bandgap energy per change in lattice constant compared to commonly used InGaAs alloys and, therefore, the potential for GaAs-based optoelectronics applications at longer IR wavelengths. However, Bi is incorporated into GaAs only at temperatures ≤400°C, and GaAs grown at these temperatures is known to have high densities of point defects. GaAs grown by molecular beam epitaxy (MBE) at standard temperatures (560-600°C) typically has point defect concentrations in the 1013 cm-3 range or lower, whereas n-type GaAs grown at 330°C has electrically active defect concentrations in the $10^{18}$ $cm^{-3}$ range [1,2]. Incorporating Bi into n-GaAs at 330°C suppresses the dominant defect, thus reducing the total defect density by a factor of 20 [2].

Deep level defects in GaAs layers grown by MBE have been investigated by Deep Level Capacitance Spectroscopy, which detects electron and hole trapping in the depletion region of a Schottky or one-sided abrupt p/n junction diode. N-type GaAs grown at temperatures 565-580°C has electron trap concentrations ≤ $4x10^{13}$ cm-3 and hole trap concentrations ≤ $9x10^{13}$ $cm^{-3}$. The activation energy of the dominant hole trap is 0.42 eV. However, p-type GaAs layers grown at similar temperatures were found to have an order of magnitude higher hole trap concentration with the activation energy of the dominant trap in the range 0.39-0.46 eV, depending on the measurement conditions. The concentration of this trap is the same in p-GaAs grown at 370°C, suggesting that the defect is likely impurity-related. Commonly observed hole traps in p-GaAs are Fe with activation energy at 0.52-0.59 eV and two different Cu defects with activation energies 0.42-0.44eV and 0.15-0.17 eV [3,4]. This suggests that Cu impurities may be present in our samples. Cu contamination during the metal contact anneal has been ruled out and other possible sources of Cu contamination are being investigated. Initial measurements of p-type $GaAs_{1-x}Bi_x$ with x=0.7-0.9 show that additional trap species are present with concentrations in the $10^{15}$ $cm^{-3}$ range when the growth temperature is 370°C and increasing to the $10^{16}$ $cm^{-3}$ range when the temperature is reduced to 330°C, comparable to n-type $GaAs_{1-x}Bi_x$ with similar Bi fraction. These results show that $GaAs_{1-x}Bi_x$ needs to be grown at the highest possible temperature to minimize electrically active defects.

1. D.C. Look, *et al.*, Appl. Phys. Lett. **62**, 3004 (1993).
2. P.M. Mooney, *et al.*, J. Appl. Phys. **113**, 133708 (2013).
3. D.V. Lang and R.A. Logan, J. Electron. Mater. **4**, 1053 (1975).
4. A. Mitonneau, *et al.*, Electron. Lett. **13**, 666 (1977).

### Poster 20. Aerogel Blanket Insulation: Experimental Validation of Analytical Thermal Conductivity Model

**Atiyeh Hoseini**, Mehdi Andisheh-Tadbir, Majid Bahrami
*Simon Fraser University*

Precise information on the rate of heat transfer in insulation materials is crucial in insulation industry. An important parameter in insulations performance analysis is the effective thermal conductivity. This poster presents a new theoretical and experimental study on the effective thermal conductivity of aerogel blankets. The proposed analytical model considers a unit cell that consists of a cylindrical fiber coated by aerogel particles. The model accounts for the solid and gas conduction as well as radiation as the pathways for heat transfer in applications ranging from cryogenic to high temperature installations. Two types of aerogel blankets were tested and it is shown that the effective thermal conductivity model matches well with the experimental data.

Using the proposed model, sensitivity analyses are performed to investigate the effect of porosity, fiber thermal conductivity, and blanket pore sizes. The results indicate that the effective thermal conductivity of aerogel blankets are highly dependent on temperature and porosity

**Poster 21. Superconducting Nanowire Single Photon Detectors Integrated with Silicon Photonics**

Mohsen K. Akhlaghi, **Ellen Schelew** & Jeff F. Young
*University of British Columbia*

We present our work on implementing superconducting nanowire single photon detectors on a silicon-on-insulator platform. In our design, coherent perfect absorption is used to achieve near ideal absorption of photons by arbitrarily small superconducting nanowires. Our waveguide integrated detector not only outperforms any detector reported to date, but closely approaches an ideal one in terms of efficiency, noise and speed.

**Poster 22. Development of New Composite Adsorbent Materials with Increased Thermal Conductivity for Adsorption Cooling Systems**

**Khorshid Fayzmanesh,** Claire McCague, Majid Bahrami
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Adsorption cooling systems which utilise waste heat generated by engines to produce cooling power for automotive A/C purposes are a green technology with great potential to reduce demand for primary energy. Adsorbent material drives evaporation to produce cooling power and is regenerated with low grade heat (~80°C). Coating a thin layer of adsorbent on the surface of the adsorber bed heat exchanger can improve heat and mass transfer. Major challenges facing in coated adsorption cooling systems include: material durability, coated Material thickness and material adsorption uptake. The overall performance of adsorption cooling systems can be improved by development of new composite materials with high adsorbent uptake and increased heat and mass transfer properties. In this study, silica gel with surface areas ($S_{BET}$) of 494 $m^2/g$ was combined with organic binder, hygroscopic salt and thermally conductive additive consisting of graphite flakes or copper power to produce composite material. The porosity of composite material was evaluated by nitrogen adsorption surface area analysis and its thermal properties determined with a transient plane source thermal analyser. The water uptake and durability tests of the composite materials under adsorption cooling cycle conditions were measured with a thermogravimetric vapour sorption analyser.

**Poster 23. Sub-nanosecond Time-resolved Near-field Scanning Magneto-optical Microscope.**

**J. Rudge**, J. Kolthammer, H Xu, and B.C. Choi
*University of Victoria*

We report on a new magnetic microscope that combines a near-field scanning optical microscope and time-resolved magneto-optical Kerr effect. By combining the high temporal resolution of time resolved Kerr microscopes with the high spatial resolution of a near-field microscope this new technique will help to develop deeper understanding of ultrafast magnetic phenomena beyond the diffraction limit at sub-nanosecond time scales. In this poster we demonstrate the technique by observing gyromagnetic motion of a vortex core in CoFeB microdots.

### Poster 24. Core/Shell NaDyF4/NaGdF4 Nanoparticles for Smarter MRI Diagnostic

Anurag Gautam and Frank C. J. M. van Veggel
*Department of Chemistry, University of Victoria*

Systematically studied relaxivities measurements show that NaDyF4 (20 nm)/NaGdF4 (~ 0.5 nm) core/shell nanoparticles have efficient r1 and r2 high relaxivity at high field (at 3T and 9.4 T). The observed r1-relaxivities were 6.2 and 5.8 mM-1s-1 (i.e. per gadolinium ion), whereas the observed r2-relaxivities were 22 and 124 mM-1s-1 (i.e. per dysprosium ion) at 3 T and 9.4 T respectively. The systematically studied were done by synthesizing six sets of NPs of nearly same size (~20 nm). The four sets of core/shell NPs were NaDyF4/NaGdF4, NaDyF4/NaYF4 NaYF4/NaGdF4, and NaYF4/NaDyF4 while the two sets of control NPs were NaDyF4 and NaYF4. The surface of the NPs was modified with poly(maleimide-*alt*-1-octadecene) (PMAO) that was chemically modified by reaction with poly(ethylene glycol) amine (PEG-NH2) and ethanolamine. We further investigated the basic cytotoxicity study, bio-distribution, and *in vivo* imaging in animals with surface modified NaDyF4/NaGdF4 core/shell NPs. The basic cytotoxicity study showed no adverse effects in Balb/C mice even at highest dose of 58 mg kg-1 of mice body weight. Additionally, the bio-distribution studied of Balb/C mice and CD 11 nude mice suggested that the liver and spleen were the most dominant organs were the NPs are accumulated after the post injection. Finally, the MR imaging were performed on the brain tumor of CD 11 nude mice and prostate of Wistar rat, that proven the potential of NaDyF4 /NaGdF4 core/shell NPs in the MR imaging

### Poster 25. Dynamic Demagnetization Effects in Dual Vortex Nanopillars during Current Pulse Induced Chirality Switching

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Present day and proposed information technologies increasingly depend on integrated magnetoelectronic elements, particularly for high-density nonvolatile storage and low-power logic devices. In this study, circular spinvalve nanopillars ($Ni_{80}Fe_{20}$/Cu/Co, $\varphi$ = 100 nm) supporting a parallel-core, dual vortex ground state are investigated numerically. Sufficiently energetic spin torque excitation (via an individual subnanosecond current pulse with density on the order of $10^8$ A/cm$^2$) can unwind the free ($Ni_{80}Fe_{20}$) layer vortex, driving it over an energy barrier and into the opposite chirality. Two main features are evident in the resulting nonlinear dynamics. First is the generation of order-GHz spinwave eigenmodes, dominated by a radial magnetostatic mode initiated by precession at the outer edge of the free layer. Second, the interlayer phase relationship and overall precessional frequency of the pillar depend on the relative pillar chirality. While the harder Co layer is hardly perturbed in comparison to the free layer, these effects show that the dynamic response of the pillar depends strongly on the dipole field's demagnetization effects and interlayer coupling. Finally, the pulse parameter space is explored in terms of the coherence and end result of the switching process. Successive current pulses with selected amplitudes and widths can toggle the free layer chirality, and the bistable parallel- and antiparallel-chirality states are readable via the giant magnetoresistance effect.

## Poster 26. Platinum Deposition on Poly(3-Hexylthiophene) and its Photocathodic Activity in Aqueous Acid

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Generation of solar fuels is currently an area of intensive research. Many materials exist that can be used as photoelectrochemical electrodes. Typically, inorganic semiconductors are employed but organic semiconductors have also been shown to be useful for photoelectrochemistry[1–3], but little research has been done on their water splitting ability.[4,5] The conduction band of regio-regular poly(3-hexylthiophene) (P3HT), a p-type semiconductor, is higher than the reduction potential of protons. Electrons promoted to the conduction band due to absorption of visible light have sufficient energy to reduce protons to hydrogen. Previously, we have shown that when P3HT is illuminated in 0.1 M $H_2SO_4$, a photocurrent is produced.[6] Despite stable photocurrents no hydrogen was detected, indicating a co-catalyst is needed. Platinum, a common catalyst for hydrogen reduction, was deposited under visible illumination, from solutions of low concentrations of the precursor, $K_2PtCl_6$, (0.1, 0.25, and 0.5 mM in 1 M $H_2SO_4$) at two different potentials( -0.1 and -0.3 $V_{SCE}$). Deposition in 0.1 mM $K_2PtCl_6$ / 1 M $H_2SO_4$ results in films that produce photocurrents up to -60 μA $cm^{-2}$ under visible illumination (100 mW $cm^{-2}$, 300-700 nm) and very small dark currents ( < 1 μA $cm^{-2}$) at -0.24 $V_{SCE}$ in 0.1 M $H_2SO_4$. The photocurrent also shows a pH dependence. Photoelectrolysis for hydrogen evolution was performed at -0.24 $V_{SCE}$. The photocurrent decreased over 4 hours but GC analysis showed generation of a small amount, 1.8 μmol, of $H_2$.

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**Poster 27. Carbon Related Shallow Bound Exciton Transitions in ZnO Nanowires Grown by MOVPE**

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Several shallow donor bound exciton photoluminescence (PL) transitions are reported in ZnO nanowires doped with carbon. The emission energies are in the range of 3360.8– 3361.9 meV, close to previously reported emission lines due to excitons bound to donor point defects, such as Ga, Al, In, and H. The addition of small amounts of hydrogen during growth results in a strong enhancement of the PL of these carbon related emission lines, yet PL and annealing measurements indicate no appreciable bulk hydrogen. The observation of two electron satellites for these emission lines enables the determination of the donor binding energies. The dependence of exciton localization energy on donor binding energy departs somewhat from the usual linear relationship observed for group III donors, indicating a qualitatively different central cell potential, as one would expect for a complex. Emission lines due to excitons bound to ionized donors associated with these defects are also observed. The dependence of the PL emission intensities on temperature and growth conditions demonstrates that the lines are due to distinct complexes and not merely excited states of each other.

**Poster 28. Measuring the 3$^{rd}$ Unknown Dimension of Strain in Si/SiGe Crystals Using Split-HOLZ line Interferometry**

**Mana Norouzpour**, Rodney A. Herring
*University of Victoria*

A characteristic of the majority of semiconductor nanostructures is the presence of lattice strain varying on the nanometer scale, originating from the lattice mismatch between layers of a different composition deposited during epitaxial growth. Presently, the only tool capable of measuring strain at the nanometer-scale with the spatial resolution below 5 nm is Transmission Electron Microscopy (TEM). All previous approaches using TEM measure two dimensional strain (2D) of the crystals three dimensional (3D) strain distribution. The missing third dimension is the strain passing the crystal parallel to the interrogating electron beam. Knowing the 3D strain in crystals is highly desired for crystal growers and microelectronic device manufacturers since strain creates undesirable defects that can destroy the beneficial properties of the crystal but in some cases can be used positively to enhance a device's performance. In this research we report a new technique that enables the measurement of the through-thickness strain of a crystal that in turn enables the determination of the crystal's three dimensional (3D) strain. This new method includes self-interfering of a split higher-order Laue zone (HOLZ) line produced from a strained $Si/Si_{1-x}Ge_x$ specimen. The missing information contained in the phase of the interrogating electron beam passing through the crystal is recovered by split HOLZ line interferometry. This new method can be broadly applied to the many 2D strain measurement methods already established providing them with the through-thickness strain required for their determining the 3D crystal strain.

## Poster 29. Schottky Junctions by RF Magnetron Sputtering of Zinc Oxide on Silver Films

**Finlay MacNab**
*Simon Fraser University*

Schottky contacts to zinc oxide have been widely studied for application to microelectronics and optoelectronic applications, including UV photodetectors, and dye sensitized photovoltaic devices. The quality of ZnO/metal junctions is highly dependent on the surface properties of the semiconductor. Junction properties are generally enhanced by high temperature processing techniques and post deposition surface treatments, which typically necessitate a metal on semiconductor device design. In this study we present a novel process for the fabrication of zinc oxide on silver Schottky junctions by r.f. sputtering of zinc oxide onto thermally evaporated silver films under mild process conditions. Rectification ratios of $10^5$ and current densities of > 1 A/cm$^2$ at 1 V forward bias are typically observed.

## Poster 30. Plasma Assisted Molecular Beam Epitaxy Growth and Characterization of $Zn_3N_2$

**Peng Wu**[1,4], Helaleh Alimhammadi[1], Mostafa Masnadi-Shirazi[1,2], Vahid Bahrami-Yekta[1], Tom Tiedje[1], Wei Li[3], Cong Wang[4]
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[4] *Beihang University, Beijing, China*

The use of plasma assisted molecular beam epitaxy (PA-MBE) as a method for producing solid host crystal has been investigated. Single crystal zinc nitride has been grown on A-plane sapphire substrates.

The (11-20) Al2O3 substrates were annealed in air at 1150˚C centigrade to generate atomically smooth surfaces with parallel atomic step. This process was important for maximizing structural quality and minimizing surface roughness of the grown Zn3N2 film.

The films were probed during growth using in-situ techniques. Reflection high energy electron diffraction (RHEED) is used to provide real time information about the crystal structure of the film surface. Light scattering can give information about surface roughness and film thickness.

This will primarily involve further measurements using the two key characterization methods, X-ray diffraction and photoluminescence, for the structural and optical properties respectively. The crystal structures of film were analyzed post-growth by high-resolution x-ray diffraction (XRD) with the 0.154056nm wavelength. (400)-oriented Zn3N2 thin films were grown on a-plane (11-20) sapphire substrates. Photoluminescence (PL) involves shining light onto a sample to induce optical transition and the resulting emission is then collected and analyzed.

The van de pauw method was involved for sheet resistivity, hall coefficient and majority carrier mobility.

At the same time, we purchased powder $Zn_3N_2$ from Johnson Matthey Company, for comparing with the $Zn_3N_2$ thin film.

**Poster 31. Single Particle ICP-MS for the Detection of Metal-based Nanoparticles in the Environment**

**Toby Astill**
*PerkinElmer*

Engineered Nanomaterials (ENMs) are synthesized by a manufacturing process that produces and controls ENMs to have at least one dimension in the range of 1 to 100nm in size. ENMs often possess different properties than their bulk counterparts of the same composition, making them of great interest to a broad spectrum of industrial and commercial applications. The widespread use and application of ENMs will inevitably lead to their release into the environment, which raises concern about their potential adverse effects on the ecosystems and, subsequently, human health.

This poster goes over the theory of Single Particle ICP-MS (SP-ICP-MS), the importance of data acquisition speed, and describes its use in analyzing metal-based Nanoparticles. The single particle analysis technique allows for the differentiation between ionic and particulate signals, quantitation of each fraction, the measurement of particle concentration (particles / mL), determination of particle size and size distribution. In addition, it allows the user to explore particle agglomeration.

SP-ICP-MS is a key analytical instrument in assessing the fate, behavior and distribution of (ENMs) in several types of matrices (environment, food, etc.). It is an essential technique used in evaluating ENMs bioavailability and bioaccumulation in the biota, and improving bio-labeling capabilities as well as furthering advancements in the field of nanomedicine.

**Poster 32. Incorporation of Retinoic Acid Releasing Microspheres into Aggregates of Pluripotent Stem Cells for Inducing Neuronal Differentiation**

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Pluripotent stem cells (PSCs) can form any specialized cell type found in the body. This property makes them an excellent tool for regenerative medicine applications. Directed differentiation of PSCs into specific phenotypes can be accomplished by introducing specific chemical cues, such as retinoic acid. Retinoic acid (RA), a small molecule, can be used to induce the differentiation of PSCs into motor neurons. It can also be incorporated into biomaterials for controlled delivery to induce PSC differentiation. Here, poly(ε-caprolactone) (PCL) microspheres containing RA were incorporated into the interstitial sites of murine ESC (mESC) aggregates with the end goal of promoting neuronal differentiation.