Matls 701/702 Seminar Series Spring Term Schedule

Thursday's at 2:00 p.m. – 2:40 p.m.
MS Teams - ffuvgr3

Date	Speaker	Title
May 13	Jingy Qu	All-Solid-State Lithium Battery Materials and Characterization
May 20	Ryan Wang	Moisture stable FAPbI3 perovskite achieved by atomic structure negotiation
May 27	Isabella McDonald	Corrosion Performance of High Temperature Alloys in Molten Salt Mixtures for Next Generation Energy Systems
June 3	Caroline Wojnas	Towards Developing HIC-resistant Sour Service X70 Pipeline Grade Steel
June 10	Nizia Medes Fonseca	Bendability of Advanced High Strength Steels
June 17	Qinfu Zhao	Composite Coatings with Advanced Functional Properties Fabricated by Electrochemical Methods
June 24	Wenyu Liang	Advanced Electrode Materials and Fabrication of Supercapacitors

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Jingyi Qu
Ph.D. Candidate

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All-Solid-State Lithium Battery Materials and Characterization

As the urgent demand for safe, high energy density, high power density and long lifespan Lithium-ion batteries (LIB), the all-solid-state electrolyte-based lithium battery (ASSLB) becomes a very competitive candidate by replacing the liquid electrolyte for next-generation energy-storage device, especially for electric vehicles. Many advantages of ASSLB in terms of physical form, safety, thermal stability, assembly convenience, etc. are outstanding over conventional liquid ones, thus attracting lots of interest from researchers. However, there are still some limitations such as poor ionic conductivity and compatibility with electrodes for the solid electrolyte materials confining the wider application.

In this talk, fundamentals and literatures on ASSLB with various solid electrolyte materials will be reviewed. To improve the performance of promising ASSLB and uncover the mechanism, some effective modification methods such as atomic layer deposition (ALD) and advanced electrochemical, structural and chemical characterization techniques including electrochemical impedance spectroscopy (EIS), scanning transmission electron microscopy (STEM) and electron energy loss spectroscopy (EELS) will also be introduced.

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Thursday, May 13, 2021
2:00 p.m. – 2:40 p.m.
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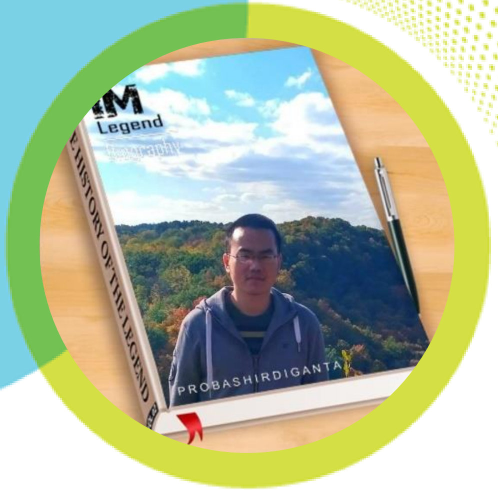
Ryan Wang
Ph.D. Candidate



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Moisture Stable FAPbI3 Perovskite Achieved by Atomic Structure Negotiation

Broad impact may be anticipated to the research community when the materials properties are capable of being manipulated artificially. Such possibility has been explored here by $FAPbI_3$ perovskite structure of the PSC solar cells, which involves undesirable phase transition at working temperature, despite many attempts to resolve the issue. Essential steps have been made here towards solving this problem by adopting opposite strategy to incorporate the water molecules into the perovskite structure, under the current materials framework by new structural physics maneuvering. The secondary bonding of the perovskite structure has been relocated, which altered the microstructure to remove the internal strain that caused the phase transition, resulting in not only a 10-fold enhancement in the moisture/structure stability, but also a comparable bandgap of the favorite α-$FAPbI_3$. A fresh structural maneuvering engineering method was proposed under the current materials framework by structural physics negotiation. The materials properties have been successfully modified via relocating the secondary bonding of the perovskite, which altered the atomic structure. A unique strain engineering method has thus been developed based on the discovery, which tried to enlarge the unit cell of the $FAPbI_3$ perovskite to remove the internal strain to enhance the thermal/moisture stability, instead of controlling the annealing conditions that have been widely adopted previously. All this opens unprecedented avenue in the perovskite research, which will hopefully be of intrinsic interest to the broad materials research community as well.

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Thursday, May 20, 2021
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Caroline Wojnas
M.A.Sc. Candidate

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Towards Developing HIC-resistant Sour Service X70 Pipeline Grade Steel

The microstructure of steel is well-known to affect hydrogen-induced cracking (HIC) susceptibility by having certain heterogeneities serving as effective hydrogen trap sites. A consensus on whether or not fine-scale niobium carbide (NbC), nitride (NbN) and carbonitride (Nb(C,N)) precipitates can behave as hydrogen traps has yet to be established. The hydrogen-trapping capacity of Nb precipitates in a Fe-C-Mn-Nb model steel was investigated with the goal of minimizing embrittlement effects and improving the design of X70 pipeline grade steel for sour service oil and gas applications. Electrochemical charging of the model steel will be conducted using a deuterium-based electrolyte. This will enable direct observation of hydrogen-trapping sites with atom probe tomography (APT) by allowing for differentiation between deuterium and environmental hydrogen. The location of hydrogen relative to trap sites will be distinguished in the APT data via analysis of 3D elemental maps of the detected deuterium. The size, shape, volume fraction, distribution, and D-trapping capacity of NbC, NbN and Nb(C,N) precipitates shall be determined as a function of heat treatment with sub-nanoscale resolution and near-ppm elemental sensitivity.

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Thursday, June 3, 2021
2:00 p.m. – 2:40 p.m.
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Isabella McDonald
M.A.Sc. Candidate

Matls 701/702 Seminar Series

Corrosion Performance of High Temperature Alloys in Molten Salt Mixtures for Next Generation Energy Systems

Molten chloride salts have been proposed to be used as the primary coolant in molten salt reactors, and as the heat transfer fluid in concentrated solar power plants in next generation energy system design. The corrosive properties of molten chloride salts make it challenging to find appropriate structural materials for plant/system realization. In this work, two corrosion mitigation strategies are investigated to determine the relative corrosion performance of high temperature alloys in molten chloride salt mixtures: (1) chemical purification of the salt mixture using a Mg sacrificial anode and (2) developing a protective oxide layer on the surface of high temperature alloys after pre-oxidation.

Three commercial high temperature alloys were exposed to molten salts ($KCl - MgCl_2 \cdot 6H_2O$) with the addition of Mg for 100 h at 700°C. SEM-EDS characterization was used to compare cross-sections of each alloy exposed to molten salt with and without Mg additions. To assess the second mitigation strategy the three alloys were pre-oxidized to form protective chromia, alumina, and silica oxide layers. The raw and pre-oxidized high temperature alloys were exposed to the same molten chloride salts with and without chemical purification under the same conditions. SEM-EDS characterization was used to compare cross-sections of each alloy after exposure. The talk will present and discuss the progress made to date.

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Thursday, May 27, 2021
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Nizia Mendes Fonseca
PhD Candidate

Matls 701/702 Seminar Series

Bendability of Advanced High Strength Steels

COMING SOON!

Thursday, June 10, 2021
2:00 p.m. – 2:40 p.m.
MS Team - ffuvgr3

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Qinfu Zhao
Ph.D. Candidate

Matls 701/702 Seminar Series

Composite Coatings with Advanced Functional Properties Fabricated by Electrochemical Methods

Materials failure caused by corrosion has always been a great challenge in our real world. The annual global economic cost due to corrosion is tremendous and the incidents that harmed human lives due to corrosion are countless. So corrosion protection is an ageless topic in material field.

From all the corrosion protection strategies, protective coatings acting as a physical barrier between the materials and corrosive elements to stop the corrosive elements penetrated to protected materials have been studied the most. Among various kinds of protective coatings such as metal, ceramic and polymer coating fabricated by electrochemical, vapor deposition, spray or any other techniques, polymer coating produced by electrochemical deposition proved to be the most promising. Electrophoretic deposition of materials (EPD) is increasingly being used for the manufacturing of advanced films for electronic, energy generation and storage, photovoltaic, biomedical and corrosion protection.

In this presentation, advanced polymers such as PTFE, PVDF were utilized and fabricated into protective coatings by EPD technique using commercial bile acids as dispersant and charging agents. Their morphologies, deposition properties, corrosion protection properties, as well as the effectiveness of various bile acids were fully investigated, compared and analyzed.

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Thursday, June 17, 2021
2:00 p.m. – 2:40 p.m.
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Wenyu Liang
Ph.D. Candidate

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Advanced electrode materials and fabrication of supercapacitors

This research focused on the synthesis of electrode materials for the application of supercapacitors. With a desire to increase the areal capacitance C_S of the negative electrodes, FeOOH and $Ti_3C_2T_x$ based materials were synthesized and Zn-FeOOH and $Ti_3C_2T_x$-Fe3O4-CNT systems were studied. The advanced chelating dispersants and hydrophilic water-insoluble binders were utilized for the manufacturing of electrodes with high active mass up to 45 mg cm^{-2}. The ability of the electrode to achieve high C_S in 0.5 M Na_2SO_4 electrolyte opened the way for the manufacturing of asymmetric devices, which offered the benefits of increased capacitance, enlarged voltage range and low resistance.

Thursday, June 24, 2021
2:00 p.m. – 2:40 p.m.
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