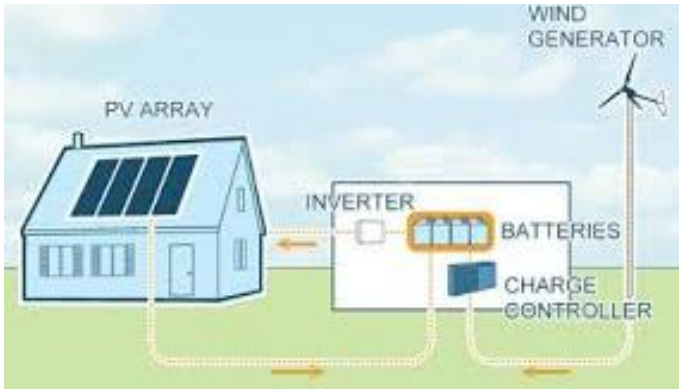
# Electrochemical Engineering
# Lecture 0 Introduction

Dr. Zhe Cheng

# Electrochemical Engineering

- **Basic electrochemistry**
- **Electrochemical engineering for**
  - Energy conversion & storage
    - batteries, fuel cells, capacitors:
      - Transportation (EV & FCV)
      - Clean power generation & storage
      - Mobile devices
  - Corrosion and prevention
  - Materials/chemicals production or processing
  - Sensors & more



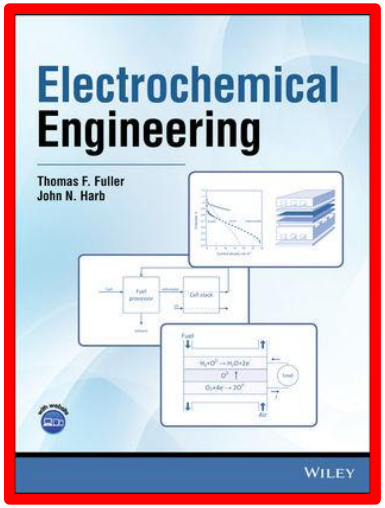


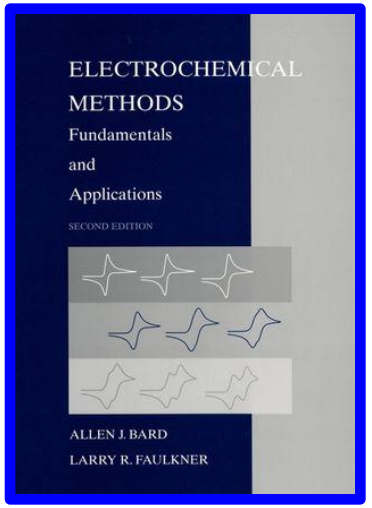

https://www.toppr.com/guides/chemistry/electrochemistry/corrosion-prevention-method/
https://bestmetaltrade.com/product/aluminium-ingot-99-7-percent/
*https://www.nisenet.org/catalog/exploring-fabrication-electroplating*

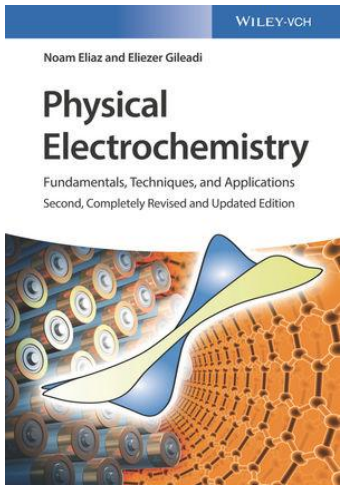
*http://www.tesla.com*
*http://www.greencarreports.com/news/1106296_price-cut-and-monthly-sales-spike-for-toyota-mirai-fuel-cell-sedan*
*http://www.dailymail.co.uk/sciencetech/article-4003522/New-phone-battery-charge-phones-just-seconds.html*
*http://www.fuelcelltoday.com/analysis/event-reports/2013/19th-group-exhibit-hydrogen-plus-fuel-cells*
*http://www.exponent.com/services/practices/engineering/materials--corrosion-engineering/?serviceId=c9288b2c-d7b1-4ad8-8fc3-1b1ed6f2c8c1&loadAllByPageSize=true&knowledgePageSize=3&knowledgePageNum=0&newseventPageSize=3&newseventPageNum=0*
*https://www.medgadget.com/2014/08/handheld-electrochemical-sensor-detects-diseases-measures-biomarkers-costs-25.html*

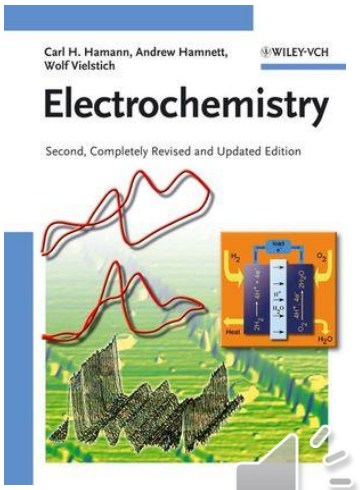
# Course Materials

- **Text:** *Electrochemical Engineering*, Thomas F Fuller and John Narb, Wiley (2018), ISBN: 978-1-119-00425-7
- **Canvas**
  - Class notes, Quizzes, Hw & more
- **Additional references**
  - *Electrochemical Methods: Fundamentals and Applications*, Allen J. Bard, Larry R. Faulkner, Wiley (2001), ISBN: 978-0-471-04372-0
  - *Physical Electrochemistry: Fundamentals, Techniques, and Applications*, 2nd Edition, Noam Eliaz, Eliezer Gileadi, Wiley (2019), ISBN: 978-3-527-34139-9
  - *Electrochemistry*, 2nd ed., Carl H. Hamann, Andrew Hamnett, Wolf Vielstich, Wiley-VCH (2007), ISBN: 978-3-527-31069-2



# Dr. Zhe CHENG & Course Website

❑ **Dr. Zhe CHENG**

- zhe.cheng@colostate.edu

❑ **Course website**

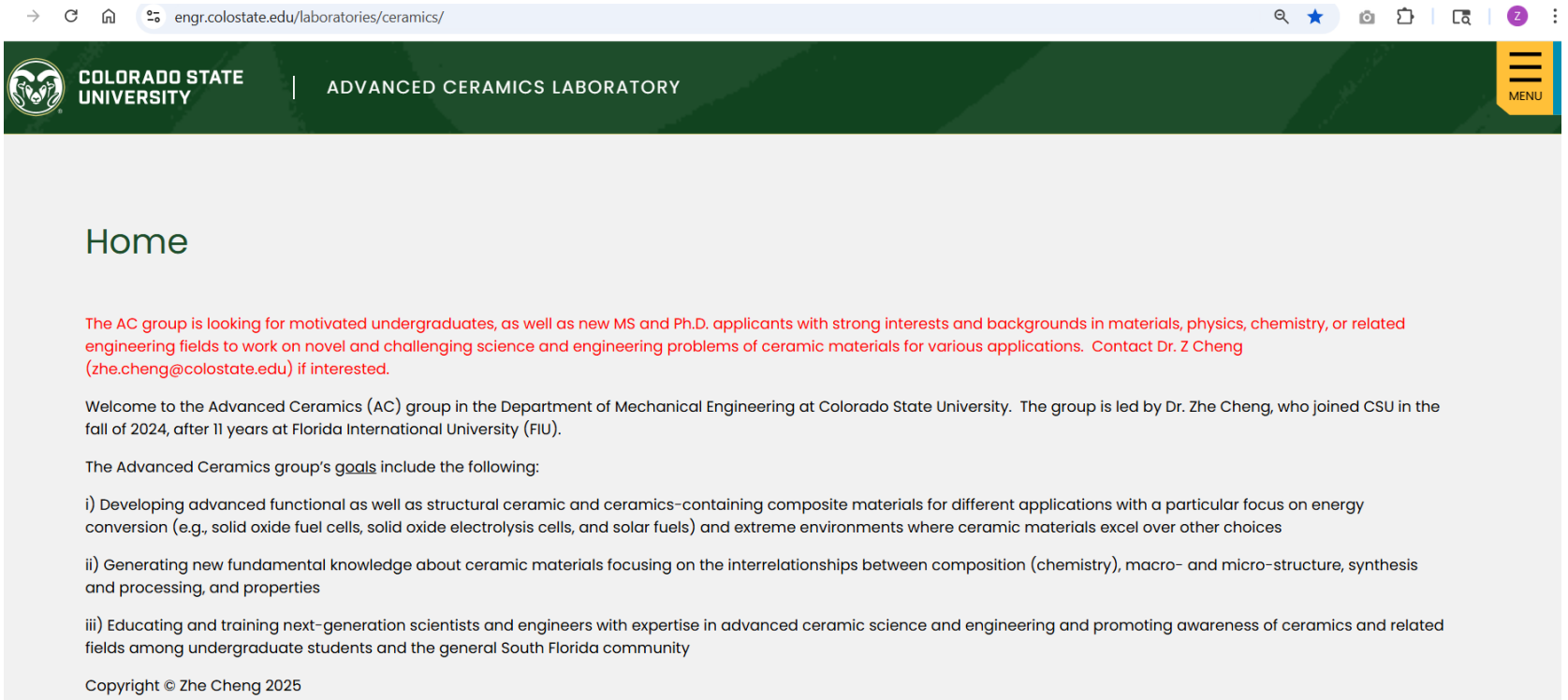
**https://www.engr.colostate.edu/laboratories/ceramics/teaching/ema5305-4303/**

# More about Dr. Zhe Cheng

## ❑Education & Experiences:

- PhD in Materials Science & Engineering, Georgia Tech, 2008
- Research scientist,  DuPont, Wilmington DE, 2008-2013
- Florida International University, Miami, FL, 2013-2024

## ❑Research group website



# Course Policy

## ❑Policy

- Students can discuss homework problems, but must **independently** finish it
- Grade discrepancies – resolve within 24 h
- Accommodate “make-up” quiz, tests, or delayed term paper if proven medical necessity
- Accommodate disability and religious holidays
- NO cheating or plagiarizing in ANY form (Check with me if questions)
  - No excuses will be accepted
  - Will be reported and handled according to policies

# Course Objective & Outcome

## ❑ Objective

Introduce to undergraduate and junior graduate students the basic concepts, physical/chemical principles, and engineering practices of electrochemistry and its applications in various electrochemical systems for energy, chemical, biomedical, and electronics industries

## ❑ Learning Outcomes

a) Understand the concepts of **electrochemical cells** and related components and the basic electrochemical processes

b) Understand the **thermodynamics** for electrochemical systems and be able to obtain basic information such as cell potential from thermochemical data and vice versa

c) Understand basic **reaction kinetics** for electrochemical systems including current-voltage relationship and the influences of factors such as transport properties

d) Understand the principles for basic **electrochemical analysis techniques** including controlled current/voltage measurements & electrochemical impedance spectroscopy

e) Be able to explain basic operating principles and identify major considerations for various **practical** engineering electrochemical **systems** including corrosion and its prevention, electrolytic production of chemicals and metals, electrodeposition, batteries, fuel cells and biofuel cells, and electrochemical sensors.

# Topics & Tentative Schedule

- Introduction: basic concepts of electrochemical cells and processes
- Equilibrium and electrochemical thermodynamics
- Electrochemical kinetics including current-voltage relationships
- Electrochemical techniques for analysis including impedance spectroscopy and controlled current and voltage techniques
- Electrochemical energy conversion and storage via batteries and fuel cells
- If time allows
  - Electrolytic production of chemicals/metals and electro-deposition
  - Corrosion (if time allows)
  - Other: electrochemical sensors (if time allows)

# Homework

Pick **a specific topic** centering on electrochemistry or electrochemical engineering and **explain briefly what specific aspect you personally would like to know more** about that topic. Notes:

- The topic has to be SPECIFIC and NOT too broad/big:
  For example, instead of "**battery**", one may choose
  - "cyclability of solid state lithium battery with ceramic electrolyte"
  - "state-of-the-art power density for lead acid battery for automobiles"
  - "current status for silicon anode for lithium-ion battery with higher capacity"
- Please declare the use of AI tools (e.g., ChatGPT) if applicable - NO points will be deducted, but please share the prompts that was used as well
- Less than 100 words
- Must be typed