

MIE 1128: Materials for Clean Energy Technologies Syllabus

Course Instructor: Prof. Olivera Kesler, kesler@mie.utoronto.ca, 416-978-3835, MC 332. Office hours by appointment – send email to set up a meeting time, using MIE 1128 as the subject line.

Course Topics, and proportions for the 13-week semester:

1. (~0.5 weeks) Brief overview of environmental issues and clean energy technologies.
2. (~ 1 week) Solar cell materials. Trade-offs between cost and efficiency. Design strategies.
3. (~ 1 week) Fuel cell materials. Overview of different fuel cell types and major materials requirements for each.
4. (~ 1 week) Solid oxide fuel cell materials. Materials requirements for fuel cell stack components, including challenges posed by high-temperature operating environments. Current materials used for anode, electrolyte, cathode, interconnects, and candidate replacement materials. Lower-temperature operation attempts and added materials requirements. Anode materials for oxidation of multiple fuels.
5. (~ 1 week) Gas turbine materials. Use of high temperature steels, nickel alloys. The gas environment: the need for protective coatings: MCrAlY and thermal barrier coatings (TBC's) based on yttria-stabilized zirconia. Processing methods: thermal spraying and related microstructures.
6. (~ 5 weeks) Conductivity in ceramics and semiconductors. Ionic, electronic, and mixed conductivity. Implications for solar cells, fuel cells, oxide layer growth in gas turbines, oxygen separation membranes for gas turbines, gas sensors.
7. (~ 2 weeks) Materials for Alternative Sources of Energy Production. Wind turbines. Geothermal, hydro, tidal, and wave power. Materials implications of operating environments and design constraints.
8. (~ 1.5 weeks) Individual topic presentations.

Evaluation: 80 % assignments
20 % final seminar presentation on a materials issue (s) related to a clean energy technology

Text: Ceramic Materials Science and Engineering by Carter and Norton (available for free from U of T library in electronic format to download). Chapter on Defects will be covered. Powerpoint format lecture notes will also be posted on the course website. Notes written on the chalkboard are only available in class.