

# 22.14: Nuclear Materials, Spring 2015

## Problem Set 1

### **Topic: Exploratory Research, Nuclear Systems**

#### **Purpose**

The world of nuclear materials, while able to be generally explained using a few core concepts, is riddled with acronyms, jargon, specifics, caveats, exceptions, and things best learned by experience. Perhaps the best way to gain an appreciation for the complexities of nuclear materials is to dive head-first into a specific example. In class today, we discussed a wide overview of possible materials failure mechanisms, reasons for material choices, and ongoing degradation issues affecting the nuclear power community. Each of you will choose one of these issues, explore the current state of knowledge through published literature, and by doing so, get to know the vocabulary and root causes of issues in nuclear materials.

#### **Assignment**

Choose one of the topics and systems from the following list:

- LWR: Grid-to-rod fretting (GTRF)
- PWR: Steam generator primary water stress corrosion cracking (PWSCC)
- LWR: Iodine-induced stress corrosion cracking
- LWR: Spinodal decomposition in welds of core structural components
- LWR: Hydriding of Zircaloy fuel rods
- BWR: Pressurized thermal shock of the vessel
- PWR: CRUD formation and CRUD-induced power shift
- Fast reactors: Oxide dispersion strengthened (ODS) alloy development, challenges, and advantages
- FHR/MSR: Fission product generation and corrosion of core materials
- PBMR: TRISO particle barrier layer fission product interaction
- SFR: Metallic fuel-cladding eutectic formation
- LFR: Liquid metal embrittlement of ferritic/martensitic steels
- Fission systems: Missing fuel pellet surface effects on cladding performance
- Fusion systems: Fast radiation damage of first-wall materials
- Tokamaks: Tungsten fuzz generation and plasma quenching
- Tokamaks: Radiation damage of superconducting materials
- All systems: Silicon carbide (SiC) development for high-temperature reactor service

Each of these topics will not be explicitly covered in depth during this course, but all will help to give you a broad overview of overarching themes in nuclear materials issues.

Your assignment is to survey the current literature with regards to one of these issues, and write a short review paper summarizing the root causes of the issue. It should briefly summarize how the issue hampers nuclear power generation, where current research is headed, and how the issue could be solved. This paper should contain, at a minimum:

- An abstract, not more than 100 words, where you very briefly show your most important findings and summarize the paper
- An introduction section, which introduces the issue and places it in context to highlight its importance. Here you should discuss the mechanics of what the issue is, which materials it affects, and how it affects its power system
- A research review section, where you show a snapshot of current work in this area. This is where you should summarize recent efforts
- A discussion section, where you extrapolate where the issue or development is headed, if/how you expect it to be solved, and what implications its solution will have on the performance of reactor systems
- A summary section, where you quickly reiterate the highlights of your article
- At least six peer-reviewed references in a properly formatted reference section
- The length should be three to five pages, including figures, tables, and references

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