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1. Differences:

- ~~H~~High temperature means more efficiency. (higher outlet temperatures)
- HTGRs have He as coolants.
- HTGRs have graphite as moderators. (extensive use of graphite)
- Both thermal/fast neutron options are available for HTGRs.
- The high temperature can be directly used for endothermic reactions.
- Online ~~/off~~ refueling vs. offline refueling in LWRs.

* not drawn to scale

2.

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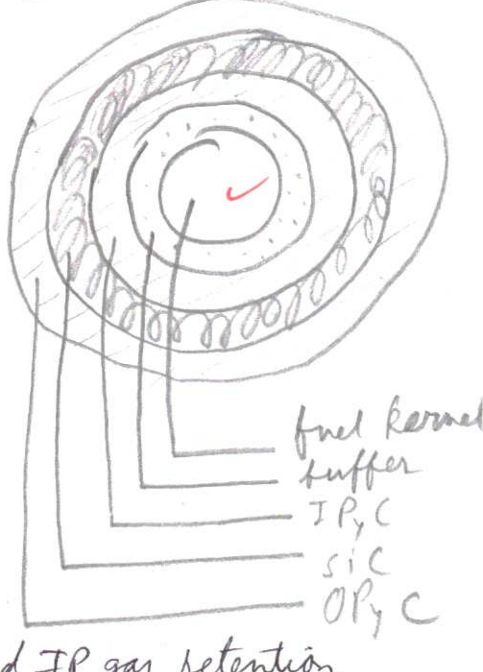
The layers are:

1. Fuel kernel
2. Buffer (Porous graphite)
3. IPyC
4. SiC
5. OPyC



- Fuel is needed for fission. (UO_2 + UC_2)
- Buffer is needed for avoiding KCMI and FP gas retention.
- PyC layers are protection for the SiC layer. -protect from what?
- SiC Layer is the pressure boundary of the fuel.

-Buffer doesn't retain gas, allows for gas release w/o overpressurization

-SiC primary fission product barrier

(3)

I had to stare at this for a while to understand ↑ it said Less

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Carbide fuels : Less fission product retention

Oxide fuels : More CO production

→ Carbide fuels can avoid CO production but they can't retain fission products.

→ Oxide fuels can retain RE fission products ~~as~~ oxides but they ~~can't~~ produce CO and that leads to overpressurization

→ That's why a 80% UO_2 / 20% UC_2 mixture is used to get the good properties of both fuels.

- ease of fabrication of oxide fuels

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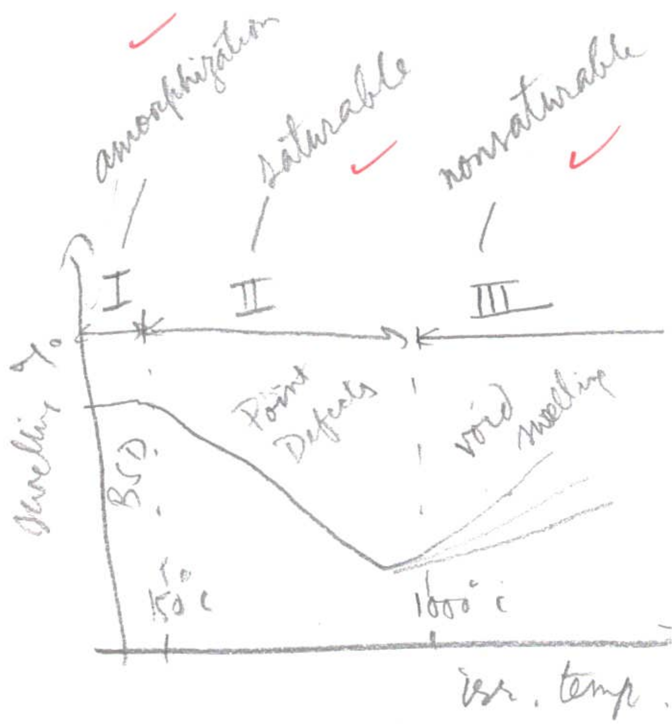
At low irradiation temperatures, black spot defects are prominent. In the saturable region, point defects are formed due to irradiation damage. In the non-saturable region, void swelling is ~~the~~ dominant ~~in the~~ for accumulating irradiation damage.



- you show correct trends, but would liked to have seen you explicitly state that in saturable regime ↑T leads to ↓ swelling due to recombination

(5) A graph of K vs T is provided here. The primary phonon scatterers are grain boundaries, point defects and voids

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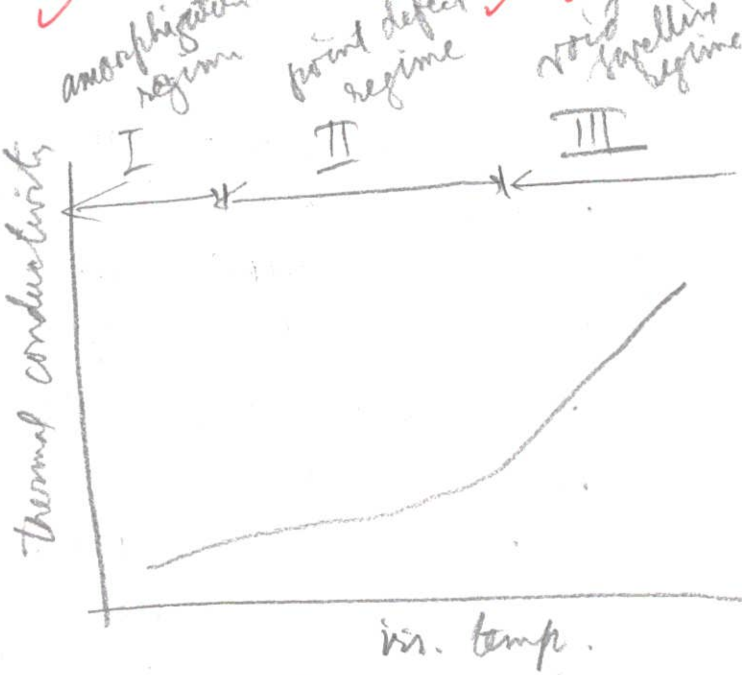
- mostly BSDs



Thermal resistance is proportional to swelling. That's why thermal conductivity can be determined from the swelling data.

- this is specifically for BSDs saturable regime

(6)

Fission product ~~(attack)~~:

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If the fission products are not retained within the fuel ~~kne~~ kernel and the buffer layer in the form of oxides and carbides, they can weaken the PyC and SiC layers. On top of that, SiC cannot retain Ag and Pd. Pd forms intermetallic compounds with SiC and Ag diffuses through it. This can lead to the failure of TRISO particles. Failure in this case can be referred ~~to~~ as the inability to retain FPs within the TRISO particle.

- SiC retains Pd, but is corroded by it
- also internal pressurization from FG release

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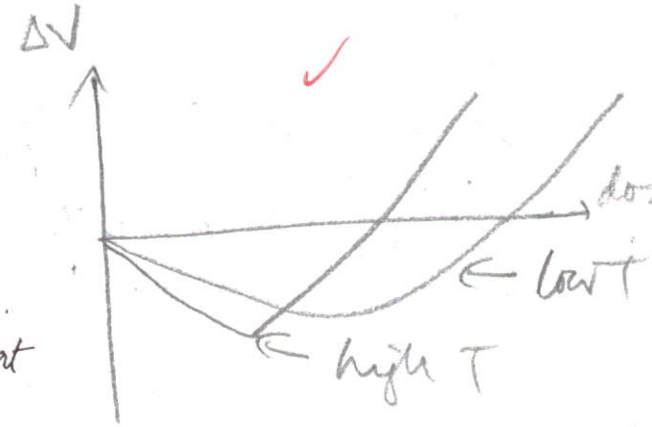
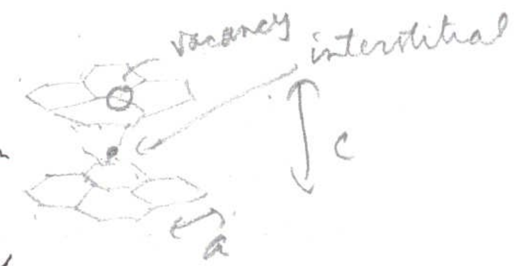
(7) The behavior of graphite is anisotropic. In the beginning, graphite shrinks and after a turnover point, it starts to swell. The turnover happens sooner ~~for~~ at high temperatures.





In the beginning, shrinkage happens because of interstitials present in between graphenes. Also, there can be vacancies in graphenes. This leads to the reduction of 'a' and increase of 'c' (overall shrinkage). After a certain point, 'a' can't be reduced anymore, and swelling occurs.

- why shrinkage? closure of Mrozowski thermal cracks

(8)

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1. Kernel migration: Due to thermal gradients kernel migration can happen. Carbon diffuses up the gradient and the fuel diffuses the other way.

2. Overpressurization: The buildup of CO can lead to overpressurization of the TRISO particle and lead to the failure of the PyC and SiC layers.

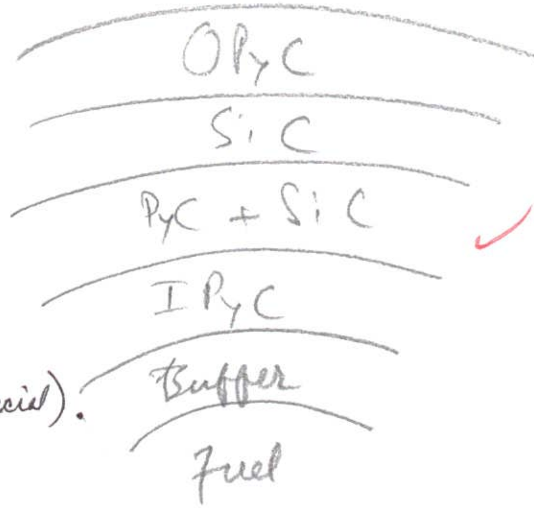
3. IPyC failure: Shrinkage due to irradiation can lead to the failure of the IPyC layer.

⑨

8/8 – Advanced concepts try to avoid the SiC failure and the release of Ag and Pd through SiC.

– The image on the side shows an additional (PyC + SiC) layer (sacrificial).

– With an additional layer, the outermost SiC layer is found to be intact and this addition also allows retention of Ag, Pd.



⑩

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1. Stress on the TRISO layers as a function of dose.
2. Creep of the layers under irradiation and stress.
3. Fission gas swelling and dimensional change as a function of dose.

One data need is the diffusion coefficients of fission products through PyC and SiC layers.