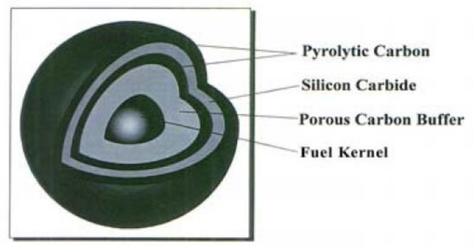
Variation of the Stochastic Strengths of TRISO Coating Layers over Irradiation

Young Min Kim[1] and Chang Keun Jo
Korea Atomic Energy Research Institute
111, Daedeok-daero 989beon-gil, Yuseong-gu, Daejeon, 34057, Korea
[1] Corresponding author: nymkim@kaeri.re.kr

Objectives

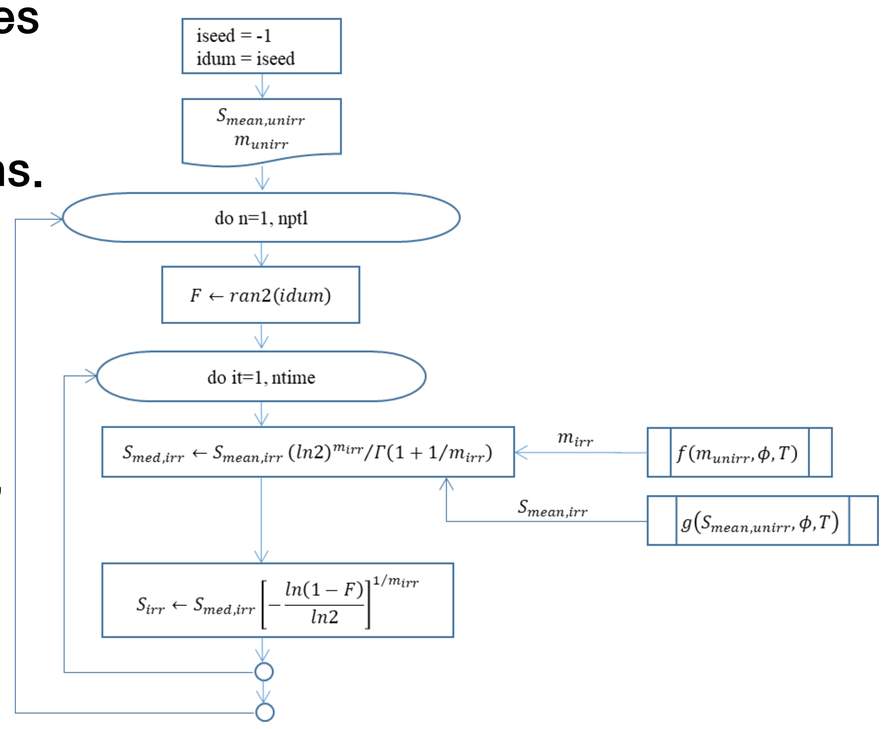
- The coating layers of a tri-structural isotropic coated fuel particle (TRISO) of a high temperature gas-cooled reactor(HTGR) broke mechanically if the tangential stress acting on their surface is greater than their ultimate tensile strength (UTS).
- This study describes the UTS of pyrocarbon and silicon carbide, and how the UTS of a TRISO coating layer changes under irradiation conditions.



A TRISO

A Stochastic Ultimate Tensile Strength

- The design parameters such as component sizes and material properties are typically sampled from Gaussian statistical distributions, while the coating layer strengths are sampled from Weibull statistical distributions.
- The unirradiated mean strength and Weibull modulus are given **experimentally.** The irradiated mean strength and Weibull modulus are given as a function of unirradiated value, density, and temperature, respectively.
- The uniform deviate *F* can be produced using a random number generator **and it** is newly calculated for every particle.



Calculation flow of a stochastic UTS

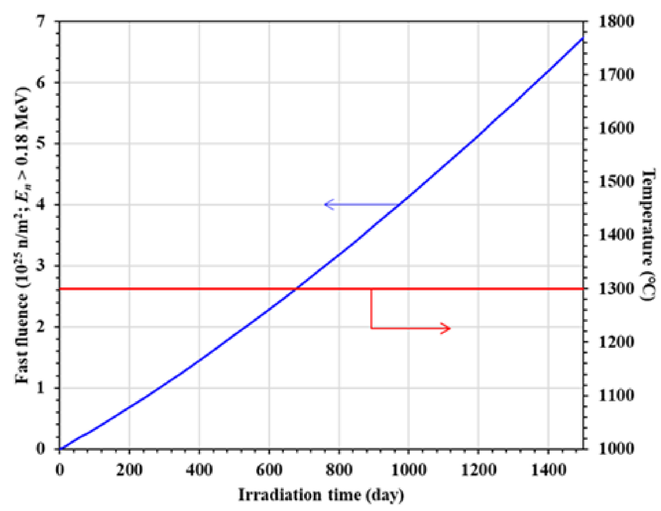
Calculation Results and Summary

Characteristics of unirradiated TRISO coating layers

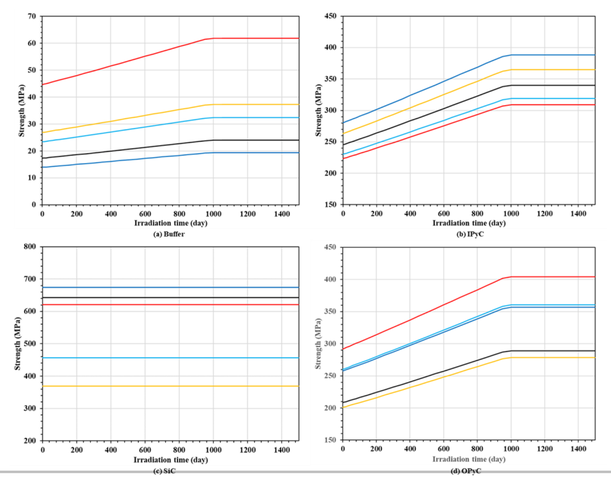
	Buffer	IPyC	SiC	OPyC
BAF	-	1.03	1	1.03
Densities (g/cm^3)	1	1.9	3.2	1.9
Weibull modulus	3	9.513	6	9.513
Mean strength (MPa)	34.5	252.7	725.0	252.7
Median strength (MPa)	27.3	230.8	632.7	230.8

- The test calculation shows that the five strengths of each coating layer for five random TRISOs are all stochastic.
- The strength of pyrocarbon approaches to a maximum value near the irradiation point of time when the fast fluence becomes 4×10^{25} n/m^2 (E_n 〉 0.18 MeV). The SiC strengths are constant throughout the irradiation because no effect of irradiation on SiC strength is assumed.

Variation of fuel burnup and fast fluence



Stochastic UTSs of the coating layers of five random TRISOs



Korea Atomic Energy Research Institute