Various ATF-concepts in Japan

- **SiC**
  - Fuel cladding (PWR, BWR), Channel box (BWR)

- **TRISO**
  - Advanced fuel well compatible with SiC clad.

- **Austenite ODS–Ferrite**
  - Fuel cladding (PWR, BWR)

- **Advanced Control Rod**
  - Control rod (PWR), Control rod blade (BWR)

- **Other Resources**
  - Test facility, Database, Modeling, Quantification

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- **PWR fuel assembly**
- **BWR fuel assembly**
R&D programs on ATF in Japan (2012~)

**SiC**
- Various Fundamental Studies (METI/MEXT)
- Feasibility study on SiC NITE-SiC/SiC (Muroran/etc.)
- Innovative fabrication NITE-SiC/SiC (Muroran/Osaka/Tohoku/etc.)
- Individual R&D on SiC utilization in LWR (MNF/Hitachi-GE/etc.)
- SiC fabrication processing (Toshiba/IBIDEN/etc.)
- Characterization of SiC composite (Toshiba/Kyoto/etc.)

**S.S.**
- Advanced austenite R&D (interrupted by earthquake, IAE/MHI/etc.)

**TRISO**
- R&D on TRISO utilization in BWR (NFI/JAEA)

**ATCR**
- R&D on ATCR or other CR-concept (CRIEPI/Toshiba)

**Test Facilities**
- Modeling, test facilities, database for fuel degradation (JAEA/NSSMC/CRIEPI/etc.)

**Modeling, Database**
- Modeling, test facilities, database Application to ATF (phase II, planned)

**Practical Utilization for Selected Concepts**
(by initiative of industry)

**ATF Feasibility Study**
"Common fundamental R&D, Collaboration in CNWG" discussed

**JFY**
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018~

**R&D programs on ATF in Japan (2012~)**
ATF feasibility project (plan-1)

- Preliminary evaluation on quantifiable improvements in reactor coping time by introducing each ATF-concept
  - Technology Readiness Level (TRL) evaluation
  - ATF metrics quantification
  - Core accident modeling/ Fuel degradation modeling
    (by collaborating institute/university/industry)

Core accident modeling

1. Analytic model & DB construction of ATF element technology (SiC, ODS, TRISO etc.)
   Oxidation, high temperature strength etc.
2. SA analysis code modification
   Candidate SA code: MAAP, SAMPSON etc.
3. Quantitative analysis and evaluation of safety improvement
   Ex) risk reduction of hydrogen explosion
ATF feasibility project (plan-2)

- Feasibility study on accident tolerant fuel and core component for utilization in LWR
  - SiC, ODS-ferrite, TRISO, ATCR, and etc.

- Common or synergetic fundamental R&D for:
  - Material development
  - Fuel performance modeling
  - Databasing, especially under irradiation condition
  - Material testing of candidates under normal or off-normal conditions

- Preliminary screening of individual ATF-concepts
- Identification of key-technology for practical utilization in LWR
ATF feasibility project (plan-3)

- Identification of test method, test facility, and other resources
- Preliminary evaluation of each ATF-concept using listed resources

- Development of test facilities, for example, for high temperature steam test

- Three test facilities already under being developed in other MET-project for “Advanced modeling and databasing of fuel degradation”
  - Fuel rod/control rod degradation test facility
    (max. temp.: ~2800K, steam atm., temp. increase: >8K/s, etc.)
  - Control blade degradation test facility
    (max. temp. gradient: 1800~1300K, test piece: ~1.2m length, etc.)
  - Degraded fuel stratification test facility
    (max. temp.: ~2800K, reductive or oxidized atm.)
Ex) Control blade degradation test facility

Prototype test facility (for Ar atmosphere)

Cross section of sim-blade

Cross section of BWR fuel assembly

Liquefied S.S./B$_4$C

~1610K (center)

Reaction with Zry

~1643K (center)

Visual inspection of degradation

⇒ Test facility for steam condition being designed and manufactured in 2015.
⇒ Stm test using Zry cladding is performed in 2014.
Summary

- Fundamental study for ATF-elemental technology had been continued mainly by initiative of universities in Japan before Fukushima accident.

- In 2012, several projects (METI/MEXT) were launched for various ATF-concepts. Also, industries in Japan started their own R&Ds for utilization in their BWR/PWR.

- Feasibility study for common and synergetic R&D planed in 2014, in which collaboration among institutes, universities and industries discussed.

- Industries consider projects for practical utilization of individual ATF-concepts (launched after common feasibility study).

- Several test facilities, models, databases being developed.