

## 3 - 1 Research Progress of the Laboratory of Advanced Nuclear Materials

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In the past 2014, the research team of the Laboratory of Advanced Nuclear Materials (LANM) paid more attention on the construction of experimental setups, R&D new materials for the accelerator driven systems (ADS), as well as the study and evaluation of irradiation effects in candidate nuclear materials.

### 1. Experimental setups

In order to meet the needs on quick evaluation of candidate materials for advanced nuclear energy systems, an experimental setup was installed at the HIRFL-SFC for studying the synergetic effect of ion irradiation and LBE (Lead bismuth eutectic) corrosion at elevated temperature was established (see Fig. 1). The experimental parameters of this setup are irradiation temperature ranging from 200 to 600 °C, velocity of oxygen controlled LBE fluid varying from 0 to 2 m/s, heavy ion energy changing from MeV to hundreds MeV, respectively.

More, two experimental setups are under construction in which one setup will be linked to 320 kV platform for tens keV to 10 MeV ion implantation/irradiation a temperature ranging from room temperature till to 1 000 °C, another setup will be installed to the HIRFL-SFC for investigating the irradiation induced creep behavior in materials under several to hundreds MeV ion irradiation at high temperature up to 1 200 °C.



Fig. 1 (color online) Experimental setup for the study of ion-irradiation/LBE-corrosion synergetic effects.

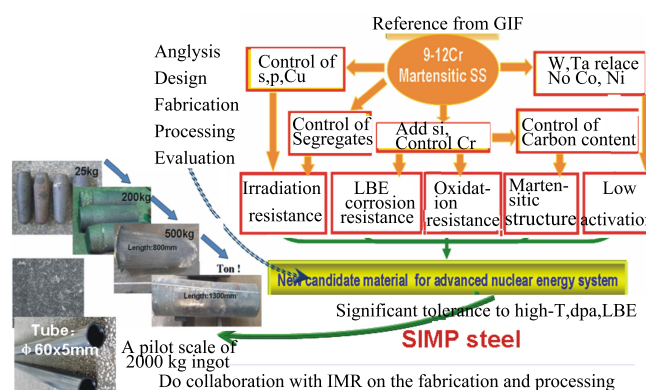


Fig. 2 (color online) R&D of SIMP steel.

### 2. R&D of new materials for ADS

The main R&D efforts are dedicated to developing and characterizing advanced materials to support the innovative design of CIADS. Optimized design, fabrication, processing and evaluation for the new materials have been done, and a novel material with a whole martensitic phase, tentatively named SIMP steel, has been fabricated in collaboration with the Institute of Metal Research (Fig. 2). The routine performance, high temperature properties as well as resistances to intense ion irradiation and liquid metal corrosion of the new material are systematically tested. It is found that SIMP steel exhibits good properties under high temperature, high stress, liquid metal corrosion and ion irradiation. At present, a pilot scale of 2 000 kg SIMP ingot has been achieved and a 5 tons scale SIMP ingot is under development.

In order to fulfill the special requirements for structural materials in the ADS, we are developing another structural material, *i.e.* SiC composites, in collaboration with Fujian Institute of Research on the Structure of Matter-CAS, and Ningbo Institute of Industrial Technology-CAS, *etc.* The fabrication is in progress.

### 3. Irradiation effects in candidate nuclear materials

A series of candidate nuclear materials such as SIMP, T91 and 316LN steels, tungsten, SiC, MAX phase materials, *etc.*, have been experimentally studied. These works are very helpful for the selection of granular target material and for the R&D of novel structural and functional materials for the future ADS system. More, some theoretical researches based on the first-principle investigation and molecular dynamics simulation have been done for the irradiation damage process in typical materials that are very helpful for understanding on the irradiation mechanism in nuclear materials.