§55. Research and Development on High Z Plasma Facing Materials

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For these two decades, major emphasis in the fusion research has been laid upon demonstration of a reactor relevant high temperature plasma. Then wall materials have been chosen always from a viewpoint to improve plasma core performance, which has led us to adoption of low Z walls. New criteria should be seriously considered for the material selection in the next step, namely, compatibility with long time sustaining of high temperature plasmas, and with an environment of DT-neutron irradiation. Based on this idea, reconsideration of plasma facing materials was proposed in 10th PSI Conference in 1992 held at Monterey with inclusion of high Z refractory metals[1)], which are attractive with their erosion-resistant property. Activities and results during 4 years from 1992 to 96 are reviewed in the 12th PSI Conference in 1996 at Saint Raphael[2)]. It has been shown that a high Z limiter or divertor could be available without serious deterioration of the plasma performance in several tokamaks. Another favorable effect named "prompt redeposition" has been experimentally verified. When the magnetic field lines are close to parallel to the striking surface, most of the sputtered high Z ions would redeposit close to the originated point due to its large gyrationradius. Detail in these experimental findings is given in ref. 2.

These promising results have opened a new possibility of material development for the plasma-facing components with high Z elements.

Strategy of the development is under discussion, and a few works have been started. The target of the development are divided into two categories. The short term target is set for application to near term devices such as LHD or ITER. One of the examples is plasma-sprayed tungsten on a carbon substrate. Thickness of the tungsten layer is 0.5 or 1.0 mm. Both isotropic graphite and CFC are used as the substrate. The test pieces are fabricated under the trilateral cooperation among NIFS, Toyo Tanso Co. Ltd. and Plansee A.G. Heat load tests are carried out with an electron beam facility conducted by Kyusyu University group.

As the long-term study, wide possibility has been surveyed and discussed. In this category, the target is set for reactor use. Long life time, low erosion rate, coolant compatibility, low activation are considered as criteria with high priority. For instance, tantalum is one of the interesting candidates. It has a similar Z number to tungsten and expected to be erosion resistant. It is ductile, corrosion resistant and a cooling pipe is commercially available. No long life, radio-active product is found after DT neutron irradiation. On the other hand, high radio-activities just after the neutron irradiation is a problem. Another concern is high solubility of tritium and possible enbrittlement due to hydrogen isotope absorption.

In LHD, impact of high Z wall will be investigated with several methods, such as laser blow-off technique, small high Z test limiter/divertor *etc.* Net erosion and hydrogen isotope behavior will be studied under real plasma-device condition. Results of the near term study will be utilized in the LHD experiments. Materials for long term study will be tested in LHD, too, if necessary.

References

1) T. Tanabe, N. Noda, H. Nakamura, J. Nucl. Mater. 196-198 (1992) 11.

2) N. Noda, V. Philipps, R. Neu, J. Nucl. Mater. 241-243 (1995).