Characterization of witness samples exposed to fusion plasma in JET reactor for studies regarding fusion plasma interaction related to ITER like wall.

For future energy generation systems like fusion systems (ITER), three elements are to be taken into consideration to be used for the first wall of the device: (i) tungsten, will be used in the divertor area (thermal energy collection and transfer area), (ii) bulk beryllium will be used for main chamber walls, (iii) carbon (or composite carbon fiber, CFC) will be used in the junction areas.

Due to erosion processes, material transport and redeposition phenomena, together with introduction of plasma energy, mixed materials will be formed.

Investigation of binary systems from constituent materials of the wall is needed to predict their physical and chemical modification.

In JET (Joint European Torus) device from Culham, UK, where an identical reaction chamber wall with the one to be used for ITER device in France is in experiment, an important amount of mixed materials like Be-C, Be-W or Be-C-W was produced. Their analysis using IBA (Ion Beam Analysis) is very important to determine films depth profile, gaseous inclusions like He, N, Ne and hydrogen isotopes. These data will be used to understand the erosion phenomena due to fusion plasma influence and to redeposition phenomenon in certain areas of the device wall.

Formation of Be-W binary systems is of great interest due to the use of these materials inside the fusion devices walls. The phase diagram of the Be-W binary system contains compounds with known stoichiometries: $Be_{22}W$, $Be_{12}W$ si Be_2W. Among these compounds, there is an unmiscibility area and miscibility limited areas. There will be analyzing, in the case of Be and W reaction, the formation of Be_2W. Apart the phase diagram data, there are few data regarding the reactivity between Be and W. IBA (RBS, PIXE, ERDA, PIGE, NRA) measurements together with XRD and XPS analysis carried out on the same samples taken from the fusion reactor wall, will allow the identification of solid solutions or of the formed compounds as a result of fusion reactor operation. These compounds will be also physical and chemical characterized and from the point of view of the retention and release property concerning the nuclear fuel used. (H isotopes).

After the identification of composition of the samples taken from different areas of the fusion reactor, a sample set will be prepared using the thermionic vacuum arc technology (TVA), original deposition method developed within NILPRP, in order to simulate the analyzed mixed films. The samples will be obtained by co-deposition, mixed materials seeded with gaseous inclusions. Using NRA together with TDS methods, the retained gas amount within the samples will be measured as well as the remained amount, after performing certain thermal treatments in vacuum.

To accomplish the project goals, the following measurements will be carried out on 30 samples taken from JET fusion reactor and on 30 samples prepared at NIPLRP.

1. RBS, ERDA measurements: 10 days/ beam
2. NRA measurements: 15 days/ beam
3. PIXE measurements: 10 days/ beam

Data analysis and interpretation: 30 days.

Involved teams: NIPLRP, Low Temperature Plasma laboratory: 3 persons

IFIN-HH, laboratory…….