Innovative Tokamak DEMO First Wall and Divertor Material Concepts*

C.P.C. Wong

General Atomics, San Diego, California 92186-5608, USA

For the ITER design, the design guidance is to apply a beryllium (Be) layer onto the plasma-facing chamber surface. When extrapolated to the DEMO design, the Be layer will not be suitable due to radiation damage. Similarly, a carbon surface will not be suitable due to high physical and chemical sputtering rates, radiation damage of the material and potential large retention of tritium. Unfortunately, the remaining commonly proposed materials, tungsten (W) and molybdenum (Mo), could suffer radiation damage from alpha charged particle implantation. If used at the first wall, the materials will experience blistering. If used at the divertor, a nano-scale low-density fine structure will be formed, and this could result in W or Mo transport to the plasma core and severely limit the core performance. To resolve this problem, different innovative material options were evaluated. A possible solution can be inferred from the fact that boron or silicon has been used successfully to condition the walls in all high performance tokamaks. If boron (B) is to be used, real-time boronization will be required to maintain a boronized layer on the chamber wall for steady state operation. This boronized layer could also protect a W substrate in order to retain low-Z wall characteristics. To support this idea, the concept of using a thin layer of either porous-W or W-mesh loaded with B as the surface material is being explored. This B/W material should be capable of withstanding high performance plasma discharges, ELMs and disruptions, while retaining the capability of transmitting high-grade heat for power conversion. Initial development and identified requirements of this B/W wall concept will be reported.

*Work supported by the U.S. Department of Energy under DE-FC02-04ER54698.