UNIVERSITY OF OXFORD
MATERIALS

The Materials Challenge of Fusion Energy

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Abstract:

The scientific demonstration of fusion ignition is expected to be achieved in the ITER experiment being built in Provence. Thus if fusion is to become a commercial option the problems of producing materials that can withstand the extreme conditions in a future fusion reactor become critical.

I will outline the conditions we expect in a fusion reactor and how the physics depends on the key parameters of reactor size and magnetic field strength.

There are three major materials issues in the reactor environment: materials damage from the 14MeV neutron flux; erosion and melting from the enormous exhaust heat fluxes on plasma facing surfaces and; huge stresses on superconducting magnets. I will describe the work at Culham and Oxford to understand these issues and the limits to materials performance. Rapid maintenance and replacement of materials inside a fusion reactor could reduce the problems – but not eliminate them.

Reduction of plasma turbulence in fusion reactors would enable smaller reactors to ignite. The spherical tokamak programme at Culham is pursuing a configuration that may yield reduced turbulence and therefore burning plasmas at smaller size.

The upgrade of the MAST spherical tokamak is nearing completion and I will describe its goals and promise. One early goal of this programme is to test an exhaust concept that spreads the heat load over a larger area mitigating one of the most difficult materials issues. The innovation from the MAST upgrade will help reduce the size and cost of future fusion power plants.