Abstract

Alcator C-Mod operation with a single null closed divertor produces clean, $Z_{eff} < 1.3$ plasmas and two dissipative divertor regimes. For $n_e > 0.7 \times 10^{20}$ m$^{-3}$ the divertor plasma is highly recycling and radiative with high densities and low temperatures near the strike points. If the temperature near the target plates drops to $\lesssim 5$ eV, this plasma detaches from the plates over most of their surfaces. The plasma pressure there can drop by a large factor ($\sim$50-80). Known amounts of trace impurities (Ar, Ne, He) have been puffed into the high-recycling divertor, and the fraction reaching the main plasma have been measured. The “impurity shielding efficiency” of this closed divertor configuration is high in each case, with $N_{imp}^{main}/N_{imp}^{div} \lesssim 2\%$ for Ar and Ne, and $<20\%$ for He.

1. Introduction

Alcator C-Mod [1], a high field, compact tokamak with a molybdenum first wall, produces highly shaped, diverted discharges. For the results described here, the main plasma parameters were $0.6 < I_p < 1.1$ MA, $0.2 \times 10^{20}$ m$^{-3} < n_e$ (gas-fueled) $< 2.8 \times 10^{20}$ m$^{-3}$, and $1.4 < \kappa < 1.7$ with $B_T$ $= 5.4$ T. The device is designed to operate with a single or double-null divertor. While in the single-null configuration a number of different magnetic divertor geometries (“open”, “closed”, “closed with slot”) are possible[1]. Results reported here are for the “closed” divertor, shown in Fig. 1, where the scrape-off layer (SOL) plasma flows around structures which baffle it from the core. A unique feature of this geometry is the “vertical” orientation of the divertor plate surfaces at the strike points. This geometry causes recycled particles in the common flux region to be directed toward the separatrix and away from the main plasma. Electron temperature and density profiles over the inner and outer divertor plates are measured with arrays of probes. As shown in Fig. 1, there are 6 probes along the inner plate and 10 probes along the outer. Also shown is a fast-scanning probe which measures scrape-off plasma parameters above the divertor. SOL parallel heat flows to the probe are as much as $\sim 200$ MW/m$^2$ to date, and field line lengths from the probe to the divertor plate are $\sim 5$ m. At the plates, grazing angles of incidence can reduce the heat flow by a factor of $\sim 50$. However, actual heat flows to the plates are much lower than this as a result of heat dissipation in or near the divertor.