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Impedance Model for Outboard Midplane Helicity-Injection Sources[1] E.T. HINSON, R.J. FONCK, B.T. LEWICKI, A.J. REDD, University of Wisconsin-Madison — Plasma cathode current injectors are being investigated at the PEGASUS Toroidal Experiment for application to point source helicity injection start-up. Knowledge of the physics governing the impedance of the current-injecting circuit is needed for a predictive model of the helicity injection rate. Neutral fueling, particularly near the injector site, reduces the voltage necessary for a fixed injected current. For nominally fixed plasma conditions, $J \propto V^{3/2}$ is observed, up to a saturation value $J_{sat} \sim 1$ kA/cm^2. This is well in excess of estimated ion saturation current density to the injector in the plasma edge region. When the internal plasma arc is terminated, the injectors operate as simple, passive electrodes that continue to drive toroidal plasma current. Fast camera images show intermittent cathode spots on the electrode surfaces, and the voltage required by the larger electrode area remains well described by $J \propto V^{3/2}$. These observations are consistent with a model invoking a strong double layer sheath in the vicinity of the plasma cathode or electrode surfaces. Current saturation is hypothesized to be due to either the Langmuir condition for double layer sheaths, or electron saturation within the injector.

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