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Experimental Studies of Plasmoid Reconnection for Closed Flux Current Generated by Coaxial Helicity Injection on HIST

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The Spherical Torus (ST) is a leading candidate for an advanced fusion reactor due to its compactness. Transient coaxial helicity injection (T-CHI) is one of CHI schemes, and it is used to generate and ramp-up the plasma current at the initial phase of a discharge. One of the most important issues in T-CHI is whether it can establish a current sufficient for succeeding current drive and heating. Understanding the fast reconnection mechanism for the flux closure during the start-up process is the primary purpose of the T-CHI experiment on Helicity Injected Spherical Torus (HIST: R=0.30 m, a=0.24 m, A=1.25). The fast reconnection driven by plasmoid for the flux closure has been demonstrated by T-CHI in the HIST device. The intensive measurement of internal magnetic structures indicates that two or three plasmoids are generated in an elongated Sweet-Parker current sheet during the T-CHI. Here, we report that in the T-CHI start-up plasmas, (i) the observed regular oscillations of magnetic field, electron density and ion flow indicate repetitive generation of small-size plasmoids due to the magnetic reconnection, (ii) one of plasmoids grows up to a large-size, and a doublet-type ST configurations is formed as a result. Consequently, the plasmoid reconnection could be the leading mechanism for the formation of multiple X-point, i.e., the fast flux closure in the T-CHI dicharge.

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