

Amelioration of Plasma-Material Interactions and ELMs, and Improvement to Plasma Performance with Lithium Injection and Conditioning in EAST

R. Maingi¹, J.S. Hu², D. Andruczyk³, J.M. Canik⁴, A. Diallo¹, K.F. Gan⁵, E. Gilson¹, X.Z. Gong², T.K. Gray⁴, M. Huang², R. Lunsford¹, D.K. Mansfield¹, X. C. Meng⁶, T.H. Osborne⁷, D.N. Ruzic³, Z. Sun², K. Tritz⁸, W. Xu², G.Z. Zuo², Z. Wang⁹, B.D. Wirth⁹, K. Woller¹⁰, S.J. Zinkle⁹, and the EAST Team

¹ Princeton Plasma Physics Laboratory, 100 Stellarator Road, Princeton, NJ 08540, USA

² Institute of Plasma Physics, Chinese Academy of Sciences, Hefei, Anhui 230031, China

³ University of Illinois, Urbana-Champaign, Champaign IL 61820, USA

⁴ Oak Ridge National Laboratory Oak Ridge, TN 37830 USA

⁵ University of Tennessee, Knoxville TN 37996, USA

⁶ Department of Applied Physics, Hunan University, Changsha 410082, China

⁷ General Atomics, San Diego, CA 92121, USA

⁸ Johns Hopkins University, Baltimore MD 21211, USA

⁹ Los Alamos National Laboratory, Los Alamos NM 87545, USA

¹⁰ Massachusetts Institute of Technology, Cambridge MA 02139, USA

We present new results from a US-PRC boundary physics collaboration where 1) lithium (Li) powder was injected to eliminate ELMs in upper-single null (USN) shape that used the ITER-like tungsten monoblock divertor; 2) a 2nd generation flowing liquid lithium limiter was inserted into the EAST midplane and used to mitigate plasma-materials interactions (PMI); and 3) Li granule injection was used for ELM triggering studies. Li powder was injected into upper-single null H-modes using the ITER-like tungsten monoblock divertor. At constant injection rates, the ELM elimination became progressively easier, suggesting a cumulative wall conditioning effect. An edge coherent mode was evident, as typical with Li conditioning. Normalized energy confinement H_{H98y2} was maintained ~ 1.2 , above the previous ELM elimination with Li injection on the lower C divertor with $H_{H98y2} \sim 0.75$. A 2nd generation flowing liquid Li limiter inserted into EAST was found to be compatible with H-modes, even when placed within 1cm of the separatrix in RF heated discharges. A Cu plate is used for the heat sink, with a thin stainless steel coating for Li compatibility. This limiter had several design improvements over the 1st generation limiter. The heat flux exhausted by the 2nd generation limiter was up to 4 MW/m². Also, short-lived ELM-free phases were observed for the first time in EAST with increasing τ_E and transient $H_{H98y2} \leq 2$ when the 2nd generation limiter was inserted. Finally ELM triggering studies with a four-chamber Li granule injector showed a size threshold for ELM triggering probability, as qualitatively predicted by theory. *Research sponsored by the U.S. DoE under a US-PRC PMI collaboration, and by a few agencies in the People's Republic of China.