INVESTIGATION OF THE PERFORMANCE OF AN ELECTROTHERMAL PLASMA SOURCE WITH EXTENDED PULSE LENGTH *

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Electrothermal (ET) plasma sources operating in the ablation-controlled arc regime uses discharge currents with pulse lengths between 100μs to 1ms. Faster or longer or extended flat-top pulses can also be generated to satisfy various applications of ET sources. It was reported that shorter pulse length of about 300ms is more powerful but provided shorter time duration for the interaction of the plasma flow with a solid target, and that the pulse is a key parameter for effective ignition of plasma propellant interactions[1].

In this study, a circuit equation is incorporated in the electrothermal plasma code ETFLOW to generate desired pulse forms of the discharge current through varying the pulse power lumped circuit parameters, while the pulse amplitude is controlled via the input charging voltage. Pulse length for fast rise short pulses between 5 to 100μs were generated and used in the code to calculate plasma exit parameters. Current pulses with extended flat-top were also used to predict the performance for flat-top pulses up to 1000μs. Code calculations for Lexan polycarbonate, using both ideal and nonideal plasma models, have shown that the source exit parameters, with extended flat-top pulses at fixed amplitude, produce more ablated mass which scales linearly with increased flat-top pulse length up to 1000μs. However, other plasma parameters remain almost constant. This result suggests that quasi-steady state operation of ET source may provide constant exit pressure and plasma bulk velocity useful for thrusters applications. For short pulses 5-100μs with constant amplitude, the plasma exit pressure varied between 60 to 410 MPa and the plasma velocity increased from ~7.2 to 8.2 km/s. The total ablated mass for 5-100μs short pulse lengths increases with increased pulse length but with lower rate, which is consistent with published results, obtained using polyethylene capillary discharge[2].

1. L. M. Chang and S. L. Howard, “Influence of Pulse Length on Electrothermal Plasma Jet Impingement Flow”, US Army Research Laboratory Report ARL-TR-4348, December 2007.
2. L. Veron, P. Noiret and S. Roux, “Experimental Ablation Processes Study on an Electrothermal Launcher”, 12th IEEE Intl. Pulsed Power Conf., Monterey, USA, 27-30 June 1995, Vol. 2, pp. 1291-1295 (1995).

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