Influence of pulse power to dynamics of laser droplet generation

Blaz Krese & Edvard Govekar

University of Ljubljana, Faculty of Mechanical Enginineering, Laboratory of Synergetics, SI 1000, Ljublana Slovenija
blaz.krese@fs.uni-lj.si

A metal droplet can be used in various industrial applications [1]. Due to this different droplet generation processes are subject of intensive investigations. The laser droplet generation is a process where a laser pulse is used to melt the tip of the vertically fed metal wire [2]. The process phenomenologically consists of two phases. In the first phase from the molten tip of the wire a pendant droplet is formed due to the surface tension and gravity force. The second phase represents the detachment of the pendant droplet from the solid tip of the wire. To achieve this, the surface tension force needs to be overcome. In order to stimulate the detachment of the droplet we append an additional short pulse, i.e., detachment pulse at the end of the pendant droplet formation phase. In the paper we characterize experimentally the influence of the power of the detachment pulse on dynamics of the laser droplet generation. For that purpose a set of experiments were performed with a selected fixed laser pulse frequency rate while stepwise changing the detachment pulse power from 0 kW to 8kW. For the characterization of the process dynamics, scalar time series were generated from the snapshots of high speed infrared camera. Based on time series analysis we are able to observe qualitatively different dynamics regimes of droplet generation, from spontaneous chaotic [3] to forced periodic dripping when changing the power of detachment pulse from 0 kW to 8kW. Different linear and nonlinear characteristics [4, 5] are used to detect and quantitatively characterize observed dynamical regimes. The transition between observed regimes presumably resembles an intermittency scenario.

[1] GOVEKAR, Edvard, JERIC, Anze. Laser droplet generation: Application to droplet joining. CIRP ann., 2009, vol. 58, iss. 1, 205-208.

[2] KOKALJ, Tadej, KLEMENCIC, Jure, MUZIC, Peter, GRABEC, Igor, GOVEKAR, Edvard. Analysis of a laser droplet formation process. J. manuf. sci. eng., 2006, vol. 128, iss. 1, 307-314.

[3] KRESE Blaz,PERC Matjaz, GOVEKAR Edvard; Dynamics of laser droplet generation. Accepted in Chaos, March 2010 issue.

[4] KANTZ Holger, SCHREIBER Thomas. Nonlinear time series analysis. Cambridge University Press, second edition, 2004.

[5] MARWAN Norbert, ROMANO M. Carmen, THIEL Marco, KURTHS Jürgen. Recurrence plots for the analysis of complex systems. Physics Reports, 2007, vol. 438, iss. 5-6, 237-329.