Experimental and numerical study of the initial stages of explosion of thick single wire z-pinch

E. Kaselouris\textsuperscript{1,2}, V. Dimitriou\textsuperscript{1,3}, A. Skoulakis\textsuperscript{1,4}, I. Fitilis\textsuperscript{1,4}, Y. Orphanos\textsuperscript{1}, I.K. Nikolos\textsuperscript{2}, E. Bakarezos\textsuperscript{1,5}, N.A. Papadogiannis\textsuperscript{1,5} and M. Tatarakis\textsuperscript{1,4}

\textsuperscript{1} Centre for Plasma Physics & Lasers, Technological Educational Institute of Crete (TEI), Chania & Rethymnon, Greece
\textsuperscript{2} School of Production Engineering & Management, Technical University of Crete, Chania, Greece
\textsuperscript{3} Department of Natural Resources & Environment, Technological Educational Institute of Crete (TEI), Chania, Greece
\textsuperscript{4} Department of Electronics, Technological Educational Institute of Crete (TEI), Chania, Greece
\textsuperscript{5} Department of Music Technology & Acoustics, Technological Educational Institute of Crete (TEI), Rethymnon, Greece

This study focuses on the understanding of the initial phases of exploding wire plasma formation in a single wire z-pinch [1-5]. The experiments were carried out at CPPL/TEI of Crete, in a Z-pinch device capable to produce a peak current of the order of 70 kA with a rise time (10% - 90%) of 60 ns. Wires of thickness ranging from 100 μm to 300 μm were investigated. Experimental results concerning the expansion dynamics of the exploded material were obtained using a time-resolved laser shadowgraphic and interferometric methods. Additionally, time-integrated optical imaging was used for the visualization of the matter dynamics. A coupled transient multiphysics computational model based on the Finite Element Method, with material temperature-dependent properties, is developed to provide valuable insights for important quantitative parameters such as temperature, current density and expansion rate of the exploded material. The impact of the skin effect was also taken into consideration in the numerical results. The present study aims to contribute towards the investigation of the solid-to-plasma phase change problem by taking into account the intermediate transition phases.

References