Nanosecond Pulsed Laser Ablation on Stainless Steel ? Combining Finite Element Modeling and Experimental Work

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In the present work, finite element simulations to investigate nanosecond pulsed laser ablation of stainless steel under low laser fluence conditions is performed. The laser has a wavelength of 1064 nm as well as a Gaussian spatial and temporal energy distribution. The utilized model of heat transfer consists of thermal conduction, thermal convection, and thermal irradiation. Temperature-dependent material's properties including absorptivity and the instantaneous material removal by evaporation are considered. Corresponding laser ablation experiments on stainless steel are also conducted, demonstrating good agreement in the widths of the evaporated area and the heat affected zone obtained by simulation results. The 2D simulation results of single pulse laser ablation demonstrate that low laser fluences ranging from 26.53 to 46.42 J cm?2 have a significant impact on both temperature distribution and material removal profile. Particularly for the width of the evaporated area, the maximum deviation of predicted values from experimental results is smaller than 10%. The 3D simulation results of groove texturing using multiple laser pulses also shows an excellent agreement with the experimental work in terms of the resulting groove morphology.