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Three-phase 3D modelling of a laser cutting process using Smoothed Particle Hydrodynamics (SPH)

Abstract

Smoothed Particle Hydrodynamics (SPH) is used to develop a numerical model to simulate the three-phase laser cutting process for medical coronary stent manufacture. The open-source code SPHysics is used to model the interaction between the laser beam and workpiece. This enables the melt flow behaviour in the non-linear pulsed fibre laser cutting process to be modelled. The developed model considers the conversion of laser energy into heat within a very thin surface layer, heat conduction into the parent material and the phase transition between solid, liquid and vapour. Promising agreement with experimental data is obtained for predicting the penetration depth and melt ejection velocity is in acceptable agreement with the published data. Water is also incorporated in this model to help explain the wet cutting mechanism in laser cutting. It is demonstrated that the meshless characteristics of SPH are able to model the droplets ejected from kerf where it is difficult for conventional modelling. A static beam was used throughout the model development.

Keywords; Coronary stents; Developed model; Laser cutting process; Model development; Open-source code; Parent materials; Smoothed particle hydrodynamics; Thin surface layer