Piezo based beam shaping for high dynamic laser material processing in 3D – PISTOL

L. Devaraj Nair[1], C. Goppold[2], P. Boettner[3], D. Stoffel[1], A. Jahn[2], C. Jolliffe[1], M. Bach[1]

1- Physik Instrumente (PI) GmbH & Co. KG, Auf der Roemerstrasse 1, 76228 Karlsruhe, Germany
2- Fraunhofer Institute Material and Beam Technology IWS, Winterbergstrasse 28, 01277 Dresden, Germany
3- Fraunhofer Institute for Applied Optics and Precision Engineering IOF Albert-Einstein-Strasse 7, 07745 Jena, Germany

Corresponding author: m.bach@pi.de

Today's laser processing e.g. cutting, welding, ablation and surface treatment can be limited by the static or only low frequency oscillation of the beam focus. Traditionally high frequency in x-y plane oscillations of the beam has been realized with galvo-scanners. New requirements in industry are demanding for not only fast in plane motion but for high-speed active vertical distribution of the beam energy within the workpiece. For laser beam cutting of thick plates an increase of cutting edge quality is expected. In terms of laser beam welding of aluminium die cast material a significant process stability improvement is aimed in connection with a weld seam quality enhancement.
This technique can be realized by a piezo driven dynamic focus shifter directly incorporated into common laser cutting heads.
This paper presents an efficient heat management system for piezo-driven actuator assemblies that act as a beam forming module in laser machining. The actuator's performance at working frequencies above 2.5 kHz is a challenge due to self-heating, triggered by dielectric losses of piezoelectric ceramics. This work aims to find a solution to subdue the limitation of reduced operating frequencies by controlling the temperature using a coolant medium (e.g. air). A thermal simulation model depicts the influence of air on the heated actuator. Different flow rates of the air, flow regimes (laminar/turbulent), flow medium are examined to find the most advisable approach. Experimental results validate the suitability of the approach. As a result, higher working frequencies can be realized.
Additional application-oriented experimental investigations are presented, proving the functional capability and showing basic interrelations between z-modulation and process behaviour.
All activities are greatly funded by the German Federal Ministry of Education and Research (BMBF) within the incentive program "zwanzig20".