# Annular Laser Beam Intensity Distribution as a Tool to Influence the Performance of Directed Energy Deposition of Metal Powder

Andrej Jeromen, Ana Vidergar, Edvard Govekar

*University of Ljubljana, Faculty of Mechanical Engineering, Aškerčeva 6, SI-1000 Ljubljana, Slovenia,*
*E-mail: andrej.jeromen@fs.uni-lj.si*

Directed energy deposition (DED) of metal powder using a laser beam is one of the established additive manufacturing (AM) processes for metals. The metal powder is deposited by delivering it in a melt pool created by the laser beam on the surface of the workpiece. The characteristics of the process and the deposited clad depend not only on the process parameters, but also on the laser beam intensity distribution (LBID) and its interaction with the powder. The recently introduced annular laser beam (ALB) DED head with axial powder feed enables shaping of laser beam intensity distribution (LBID), which has been proven to be an influential process parameter[1]. In this contribution, the influence of LBID on the DED process and the resulting clad is investigated by considering three different LBIDs: Ring, Top-Hat and Gaussian-like LBID. Based on the experimental results, including high-speed camera images of the melt pool, measured powder-catchment efficiency, and clad properties, it was shown that the LBID has the greatest impact on process performance at a lower surface energy density, where the LBID-dependent distribution of delivered energy between the powder stream and the workpiece is most pronounced. Namely, due to the intensity peak in the center of the Gaussian-like LBID, most of the ALB energy is delivered to the powder stream, resulting in the highest powder-catchment efficiency (90%) and the smallest but unevenly distributed dilution cross-sectional area. On the other hand, due to the intensity peak at the edge of the ring LBID, most of the ALB energy is delivered to the workpiece, resulting in a lower powder-catchment efficiency (77%), but a larger and more evenly distributed dilution cross-sectional area. For the same reason, the ring LBID also outperformed the Gaussian-like and top-hat LBIDs by providing higher stability of the melt pool, lower porosity of the interface between the workpiece and clad, and higher quality of the metallurgical bond.

1. Govekar, Jeromen, Kuznetsov, Levy, Fujishima, *CIRP Annals – Manuf Tech*, **2018**, *67*, 241-244.