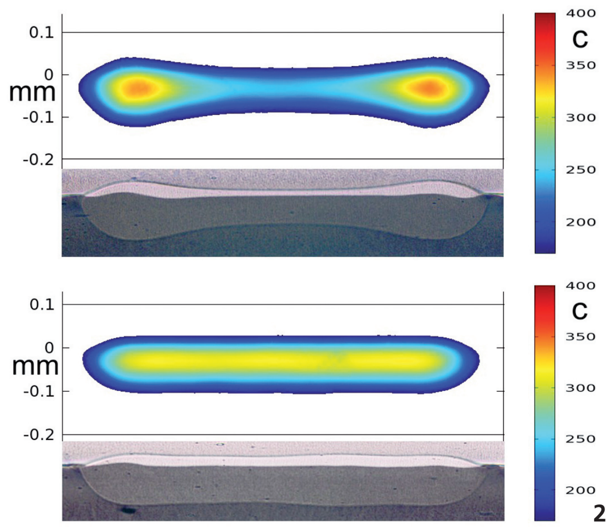

THERMAL SIMULATION OF WELD SEAM HOMOGENEITY DURING TWIST® LASER POLYMER WELDING

Task

During laser polymer welding with high-brilliance fiber laser radiation, the TWIST® method can be applied to homogenize energy deposition; in this process, the welding contour is superimposed by a fast circular or elliptical oscillation. Currently, researchers at the Fraunhofer ILT are optimizing oscillation parameters or oscillation contours in experimental studies. By thermally simulating energy deposition and subsequently melting the interface between both joining partners, the institute aims at verifying experimental results, as well as creating a means to predict and optimize it further.

Method

Based on calculating optical beam propagation during penetration of the upper transparent joining partner and material–dependent absorption in the lower joining partner, a heat source is simulated which provides input for an FEM heat conduction calculation inside the joining partners. Considered are light scattering due to the upper partner's semi-crystalline character as well as optical penetration depth of the absorbing partner. A comparison of the computed melt volume with microtome slice cuts of welded flat samples allows the verification and calibration of the simulation approach.

Result

For TWIST® welding with 0.8 mm seam width, 80 µm beam diameter, feed 50 mm/s and 2000 Hz TWIST® frequency, circle (0.8 mm diameter) and ellipse (0.8 mm and 0.2 mm axis lengths), oscillation contours are compared by means of their weld seam microtome cuts and their calculated spatial temperature distributions (Figure 2). This comparison shows that energy deposition and, therefore, weld seam geometry can be homogenized by using an ellipse-shaped oscillation, whereupon the axis' ratio is crucial for the homogeneity grade.

Applications

Thanks to this mathematical model to simulate TWIST® welding, users can optimize process parameters based on optical and thermo-mechanical material properties. This is equivalent to considerably reducing development times in polymer technology when this method is applied.

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2 Computed temperature distributions and microtome cuts for circle (above), for ellipse (below).