



3

## SIMULATION OF LASER RADIATION WELDING OF ABSORBER-FREE POLYCARBONATE

### Task

Components made of transparent polycarbonate (PC) should be welded by laser radiation without the addition of absorber particles. In the process, the laser radiation penetrates both samples and is absorbed over the entire propagation length. The process should be conducted so that the material is melted in the area of the sample contact surface. By contrast, the laser entrance and exit surfaces should not be melted or thermally modified.

### Method

For the investigation, laser radiation with a wavelength of 1650 nm was chosen since it lies in the spectral range of the first CH harmonic of the absorption spectrum of PC. Focusing optics adjust the energy density distribution in the workpiece. Fraunhofer ILT investigated the extent to which the divergence angle of the focused laser beam influences the temperature distribution, which occurs during bead on plate welding of a 2 mm thick PC sample. The temperature was determined by thermal simulation.

### Results

The simulation was carried out for the following parameters: laser power = 1.1 W, focus diameter = 50  $\mu\text{m}$  and welding speed = 240 mm/min. In Figure 3, the divergence angles 8° (left), 14° (center) and 20° (right) show the 150 and 220 °C isothermal surfaces perpendicular to the welding direction. They correspond to the glass transition or melting temperature of PC. In each case, the laser beam focus was in the middle of the component and the laser entry point in the upper edge. For 8°, the melt volume extends to the laser entrance surface. For 14° the surface temperature remains below 220 °C, and the glass transition temperature is exceeded. If the divergence angle is increased to 20°, the temperature at the laser entrance surface remains below the glass transition temperature. The maximum temperature is the same in all three cases. The simulation results can be used to design the focusing optics so that a beam distribution required for the welding task can be generated.

### Applications

The welding of absorber-free plastics is of particular interest to medical technology since it eliminates the otherwise necessary additives and absorbers.

### Contact

Dr. Mirko Aden  
Telephone +49 241 8906-469  
mirko.aden@ilt.fraunhofer.de

Dr. Alexander Olowinsky  
Telephone +49 241 8906-491  
alexander.olowinsky@ilt.fraunhofer.de

3 150 (cyan) and 220 °C isothermal surfaces (magenta).