Laser assisted atmospheric plasma spraying

Task

A multitude of plasma-, laser- and flame-based coating technologies have been established within the scope of film and surface technology. Each process is characterized by specific particularities, which, on the one hand, define the distinguished applications, on the other hand, however, the application limits. These limits are determined by economical and technical criteria. Modern hybrid manufacturing technologies connect process advantages with respect to both criteria and open completely new solutions for the surface technology. In this process combination the atmospheric plasma spraying, as a productive large-area coating process can be regarded as the basic technology. By combining this technology with the laser built-up welding we intend to remove the coat porosity, to improve the adhesive strength and to increase the mechanical load capacity of the coat-substrate composite.

Solution

In figure 1 the principle of the hybrid process is schematically presented by means of a spray gun with a sidewardly arranged laser beam. The beam creates a molten area of coating material on the component’s surface, whose diameter amounts 5 to 8 mm, depending on the beam source. The spray powder is melted in-flight in the spray gun and arrives at the laser induced molten area in a just liquid or high-ductile state. Here it will be kept on melting temperature for a sufficiently long time, so that the spray powder particles can mutually fuse. At the same time the basic material partially melts to a small degree by heat conduction, thus a melting metallurgical bond between layer and substrate is achieved. Therefore the coating process can be regarded as a built-up welding with a function distri-
Results

In comparison to a splat-type and traditional coating micro structure (fig. 4) the two material bonds in figure 5 and 6 show exemplarily by means of a cross-section polish the improved coating structure as a result of the hybrid process.

Dense systems with a fine-crystalline structure are created during the coating of steel with Ni-based hard alloys as well as during the coating of aluminium with an AlSi alloy. The adhesion to the substrate is determined by a metallurgical bond. This secures a cohesive fracture behavior, which is with a three-up to a fivefold factor higher than the characteristic adhesive fracture behavior of coatings, which have thermally been sprayed in a tensile bond test. Due to the impact of the laser beam it is possible to dispense with the traditional laborious substrate preparation by corundum beams at least in the case of the coating of steel. Here the adhesive strength is not affected.

First of all the hybrid technology is suitable for the coating of metal alloys. Figure 7 exemplarily shows a pump shaft, whose sealing/bearing face, corrosively and abrasively stressed, has been hard faced with a NiMoFe alloy.