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Combined vacuum deposition technologies for high-rate coating of 3D-parts

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Physical vapor deposition (PVD) methods have found a widespread use in several fields of application. Electron beam (EB) evaporation with axial type guns offers a productive solution in case of high material throughput. Large-area coating of metal strips is being realized economically at industrial scale. A number of high-quality oxide and nitride coatings have been developed using plasma-activated EB evaporation in experimental investigations. As examples, hardness for nanocrystalline γ -Al₂O₃ up to 22 GPa and for SiO_x up to 15 GPa were evaluated. The static deposition rates amount to more than 100 $\mu\text{m}/\text{h}$ and to dynamic rates more than 1000 nm.m/min. Furthermore, carbon-based hard coatings such as hydrogen-free amorphous carbon, titanium carbide and different tungsten carbides have been deposited by EB evaporation. As examples, hardness of 20 GPa for a-C, 33 GPa for TiC_x and 30 GPa for W-C:H layers were proved. Process characteristics and layer properties will be presented in detail. Reactive magnetron sputtering as well as plasma-enhanced chemical vapor deposition (PECVD) are versatile techniques to deposit valuable coatings on tools and parts in excellent quality. They provide coatings of a wide variety of compositions and structures, including also complex compounds. Consequently, the combination of EB-PVD with magnetron sputtering and PECVD opens up the possibility of highly effective coating processes for 3D-shaped substrates. Beyond that, the combination of these technologies in co-deposition processes, for layer stacks or gradient structures enables new and innovative features in the layer design. A novel laboratory machine platform NOVELLA integrates all three deposition technologies in a single device for coating 3D-parts. The basic design of this short-cycle equipment and first examples of use will be presented.

Keywords

3D-parts

electron beam evaporation

magnetron sputtering

PECVD

protective and tribological coatings