Die Construction of the Future

WEFA has been producing all porthole extrusion dies and flat dies in new 5-axis milling centers. By introducing 5-axis technology, we were able to significantly optimize the previous production strategy. In particular, the expenses for manual reworking as well as EDM work have decreased sharply. The elimination of processing steps also means the reduction of assembly work which is prone to error. In addition to the advantages in terms of time, the conversion to 5-axis production also creates further technological advantages.
The contour and repetition accuracy of the parts, for example, have been dramatically increased.

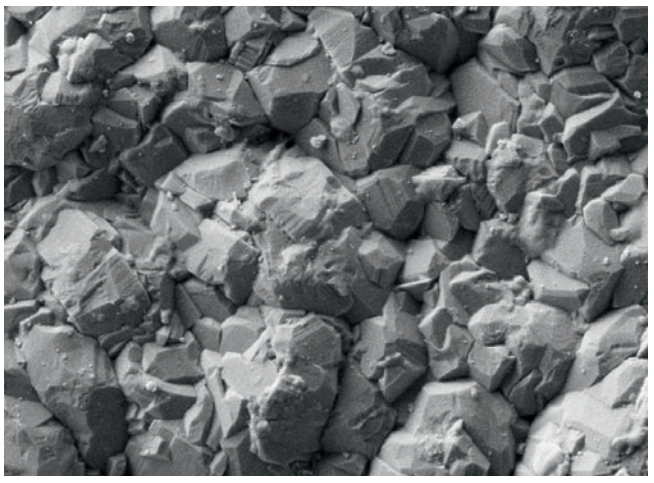

Figure 1: Al_2O_3- coating layer surface applied with HT-CVD

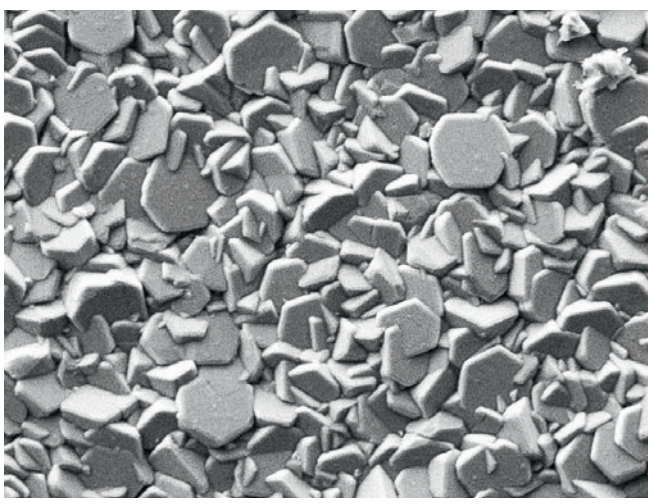

Figure 2: Al_2O_3-coating layer surface applied with MT-CVD

The generally higher production quality reduces the subsequent finishing work to the extent that only minimal grinding work is necessary in the area of the ports, feeds, etc. for rounding. This development led to a change in thinking in the design and programing departments at WEFA due to the fact that it is now mandatory to have full 3-D CAD models for all dies. The increased modeling expenses are partially balanced out by the faster manufacturing process. In addition, the increased repetition accuracy reduces expenses related to corrections.

On average, the processing time can be reduced by almost half a day by converting to 5-axis processing with its significantly increased precision. This also allows future extrusion dies to contain innovative ventilation feeds within the dies in order to cool the profiles and to create an inert gas atmosphere at the profile outlet, which is also more efficient and of higher quality.

Coating Development

The durability of an extrusion die is greatly influenced by the thermal and mechanical load during the pressing process. In particular, the main causes of die failure are abrasive and adhesive wear and tear on the die surface, thermal fatigue, as well as corrosion. In order to increase the durability of dies, both conventional nitriding processes as well as specific CVD coatings are applied to the die surfaces. WEFA has been selling coated extrusion dies (CED) under patent and trademark for years. The coating using chemical vapor deposition (CVD) offers several advantages compared to conventional nitriding processes. For example, coated dies do not require the various subsequent nitriding treatments unavoidable for nitrided dies due to thermally induced diffusion processes of the nitrogen within the structure and the accompanying softening of the surface layer. The CVD coatings, uniformly applied in terms of structure and thickness, do not require any subsequent treatments and are distinguished by a very strong wear resistance by means of optimal adhesion to the substrate as well as their superior hardness. Due to their low friction coefficient and thermal qualities, CVD-coated extrusion dies also make faster extrusion speeds in the extrusion plant possible.

There has been a shift at WEFA from high temperature (HT-CVD) to mid temperature coatings (MT-CVD) over the past years. The approx. 200 °C lower coating temperature provides several advantages. One advantage is the reduction of the thermal load of the substrate (hot-tool steel), which can significantly minimize warping, particularly for large dies. In addition, the layer structure and surface are much finer, which also allows for the improvement of, for example, the surface quality of the extruded aluminum profiles. Figures 1 and 2 show an example of the influence of the CVD-process on the surface structure of an Al2O3-coating layer. Current developments are focused on modified TiN-based CVD coatings, which offer several beneficial layer characteristics with regard to wear resistance, layer hardness and surface, as well as nanocrystalline layer structure.

Using FE-Simulations

The use of FE methods in the area of extrusion has great potential for both die design as well as in the extrusion plant. Thanks to the continuous development of software packages and the significantly improved user-friendliness and calculation efficiency, using this tool when designing difficult extrusion dies offers great advantages. Particularly for sophisticated profiles, the simulated results provide important information related to material flow and its homogeneity within the die as well as at the profile outlet. Thus, potential die deformations can be noticed and design measures taken to maintain the dimensional tolerances of the profile and to prevent the premature failure of the die. WEFA currently uses the commercial simulation packages Altair HyperXtrude and PF-Extrude, the latter developed at the ETH Zurich.

Figure 3 shows the stationary simulation results regarding profile speed for a thin-walled hollow profile as well as the real profile head. Typically, only the stationary condition of the material flow is calculated for the efficient use of FE simulation. This does not allow for a precise image of the profile head.

However, a significant inhomogeneity of the profile speed emerges from the simulated image. This information allows the user to predict when the corner and edge areas are running at a higher speed as well as flow reduction in the middle of the profile of the actual part. On the basis of these simulated results, the designer has the possibility of taking design measures and further optimizing the die prior to production. The mid-range goal is to completely or at least partially avoid sample extrusions in the extrusion plant and to increase customer satisfaction with the resulting savings in time and costs. This is particularly relevant for coated extrusion dies (CED) due to the fact that corrections are more difficult for these dies than for conventional dies. Thus, in connection with 3-D CAD/CAM and 5-Axis-Technology, a pioneering die concept is emerging.

Authors: Joachim Maier, Christoph Becker, Marcus Engelhardt

WEFA
Hall 14, Stand F25
www.wefa.com

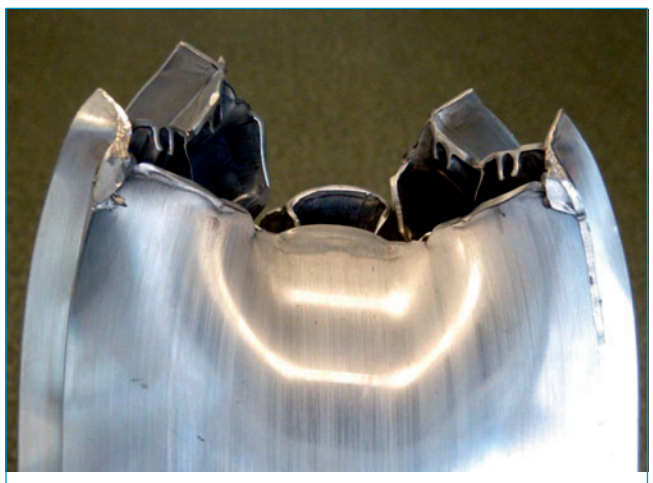

Figure 3: Real profile head and the corresponding simulation result

Photo/Graphics: WEFA

WEFA: Best dies for best profiles

Since 1972 WEFA, a family-owned die making company, produces aluminum extrusion dies for the international market. At five locations in Germany, the Czech Republic, Switzerland and the USA WEFA manufactures high-precision porthole and flat dies for profiles which are used in the automobile and construction industries as well as in electrical engineering. With the development and subsequent patenting of our own coating process, WEFA made the leap to become the global market leader in the area of coated dies. Our customers include leading aluminum companies and innovative medium-sized pressing plants. Currently the company employs over 250 highly qualified people and trains its own specialists.