Cr-based Coatings for Fine Blanking

T. SCHÄR1, M. MORSTEIN1, M. DELLER2, T. KÜNSNER3

1 PLATIT AG, Switzerland 2 Fritz Schiess AG, Switzerland 3 Materials Center Leoben, Austria

Introduction and Motivation
The fine blanking process is able to produce highly accurate pieces from sheet metal. In addition to the main cutting punch (a), a counter punch (b) works as a holder for the material during the shearing process, which together with the narrow clearance and the v-ring holder (c) suppresses the fracture zone to a minimum, Fig. 1. Therefore, no secondary operation is needed for the sheared faces and the part flatness is retained, which is a big advantage compared to conventional stamping.

State of the art for fine blanking punches
Since the punches suffer from high cyclic compressive and tensile forces during the cutting process, they are commonly made from powder-metallurgical high-speed steel (HSS). The use of cemented carbide (WC/Co, HM) as tool material is usually not an option, since it is believed not to fulfill the demands for process reliability. The evolution of the metal industry pushes the manufactures of more competitive processes (better quality, faster, cheaper, etc.). This leads to the change of the punch material and the optimal surface treatment (including applying coating) to achieve the above mentioned demands.

Aim and Methods
The aim of this work is to introduce coated cemented carbide (HM) for fine blanking punches. The main application goals are to achieve a significant increase in productivity while maintaining high production reliability. To achieve this task, the following parameters have been optimized:

- Tool macro- and micro-geometry
- Pre-treatment
- Screening of post-treatments by means of an adapted tribotest
- Screening of coating candidates (nitride and carbonitride coatings)
- Evaluating of selected coating systems by field test

All coatings were produced by cathodic arc PVD using PLATIT technology

Evaluating the Right Coating System
First findings
First fine blanking tests with non-optimized tools and standard coatings showed that the face side of the cemented carbide tool frequently flaked off early, see Fig. 4. Since simulations showed shear forces at the tool circumference to be most critical, the influence of surface roughness on friction and steel build-up were further investigated.

AlCrN based tough coatings
To enhance the lifetime of the HM punches in fine blanking applications, coatings based on AlCrN were optimized. The combination of nanolayers with Al- and Cr-rich multilayers, Fig. 6, accounts for the coating toughness. By addition of Si or Ti to AlCrN, the nanocomposite nACrτO, respectively are formed (Fig. 5).

Coating post-treatment pre-screening by tribotest
A newly developed test method was used to simulate coated tools working in steel. During the fine blanking process, the tool surfaces are in contact with virgin work piece material in every operation. To resemble this aspect of tribological contact situations, a common ball-on-disc test was modified by manually replacing the contact area on the ball with a virgin one after each lap on the disc. This test was realized on a CSM instruments ball-on-disc tester using the following parameters:

- Dry sliding test (no lubricant) at room temperature
- Ball: Ferritic steel, Rm = 900 MPa
- Load/Speed: Normal force 10 N, v = 2.4 m/s
- Test duration: 300 laps (±14 mm)
- Coated disk: AlCrN on microblasted HM Ø 32 mm

Comparing the maximum friction coefficients µmax shown in Fig. 7 with the coating’s post-treatment revealed substantially different behavior of the galling kinetics in unlubricated sliding contacts.

Conclusions from the tribotest against mild steel
- Material build-up and friction coefficient reduced at minimal surface roughness
- Lower surface roughness means less adhesion

Fine Blanking Performance
The best coating system was found to be a nanolayered AlCrN coating together with an optimized post-treatment. A remarkable increase in tool lifetime was achieved, with low scatter in the results.

Coating comparison in field test
A round HM punch for 1.0330 steel was used to compare different coatings. All the used punches were post-treated identically. Fig. 8 shows the increase of a factor 7 to the reference HSS punch.

Challenging field test
The best proven coating from above was used for a more challenging test. Not only a more resistant 1.7225 steel was cut, but also a more complex punch shape was tested. An increase of 20 times tool lifetime was achieved compared to the reference HSS punch.

Conclusions
- Nanolayered Cr-based coatings are most efficient in decreasing both abrasive wear and sticking of sheet steel material
- Post-treatment has a big influence of the coated tool surface Tribotests shows that the combination of coating and post-treatment has a big influence on friction

The newly developed coated punches are showing a huge potential to increase productivity in fine blanking with a gain of up to 20 times tool lifetime.

Acknowledgements
The authors wish to acknowledge support by the following institutions through COMET project number A5.12B and A5.18.