STRESS-FREE ta-C industrially deposited by PLD for HIGH PERFORMANCE STAMPING APPLICATIONS: Results and challenges of 1st production year.

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At the 45th ICMCTF conference we presented PLD as a new coating system technology for the production of stress-free ta-C coatings. These coatings are summarized by a very high hardness of over 60 GPa while retaining the common PVD layer thickness of 2.5 to 4.0 µm (which is previously and still standard for our PVD tool coatings coated by Sputter- and Arc-PVD). Hence, as one prerequisite, PLD allowed us to deposit ta-C without changing our tool drawings (which are proven over many years), e. g. in the case that we mix ta-C- with other PVD coatings in our high performance progressive die tools. Moreover we can avoid egg shell effects, which are a drawback if very hard but relatively thin (ca. 1 µm) coatings are used in highly stressed applications where the substrate yields underneath a thin coating (the consequence are extremely sharp, hard and therefore highly destructive coating fragments, which accelerate wear progression).

The main advantage of PLD ta-C compared to so far used PVD coatings is its almost double hardness in combination with a significantly artifact less surface. As a result the abrasion resistance against most stamping strips is significantly enhanced and active component lifetime is typically boosted by a magnitude or more – which saves tool cost and stamping press down time. As presented in 2018 our daily coating quantities and tool sizes are relatively small, even for compliance with compact PVD systems. Our PLD system therefore designed to our requirements for our final products: Complex modular die tools (with up to more than 1000 coated active elements) which are able to produce multi-millions of electrical contacts in a 24/7 operation environment without any maintenance.

In the meantime our PLD coating system has been in operation for more than one year. Driven by demanding applications, such as Si-containing high-strength bronze, stainless steel and others the ta-C coatings became smarter (e.g. integrated run-in layer, tailored hardness and Young's modulus, etc.) and more performing. Significant progress was e. g. also made regarding the inner coating of die cavities.

The purpose of the present contribution is to introduce latest developments of ta-C produced by PLD. For this purpose, relevant mechanical properties as well as new successful applications will be presented.