CrN-HP

When you need something extra...

The Tribology Centre has developed a new and improved chromium nitride coating (CrN-HP) based on the latest HiPIMS technology (see the reverse page). The coating provides a smoother, denser, harder and more defect-free CrN coating compared to conventional methods. The hardness of the CrN-HP coating is approx. 15% higher than CrN produced by a traditional PVD coating process.

PVD-Metode	**DCMS**	**HiPIMS**
Micro hardness [HV]	1800	2100
Process temperature [°C]	<180	<180
Application temperature [°C]	700	700
Thickness [µm]	1-5 til 40	1-5

CrN-HP is a versatile coating as it is very smooth, dense and ductile (flexible) while having a relatively high hardness. Therefore, CrN-HP can extend the lifetime of a wide range of tools, wear parts and machine components. CrN-HP is i.a. used in connection with injection moulding, where it increases the lifetime of the moulds as well as ensures a long-lasting high quality of the moulded items even when using abrasive color pigments or fillers. In most cases, also significantly improved release properties are achieved, which contributes to higher productivity and lower rejection rates.

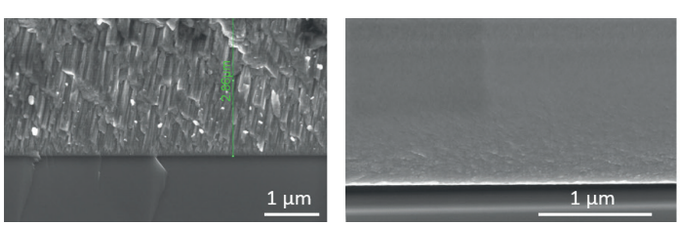
The Tribology Centre also offers the CrN-HP coating in a special Super-Slip (SS) version (CrN-HPSS), where it is combined with ion implantation. The CrN-HPSS coating is used for particularly difficult plastic materials and injection moulds.

By applying the hard CrN-HP coating to knives and punching tools, the tool life is increased and the coating ensures a higher quality of the manufactured items, because CrN-HP reduces the adhesion of metal to the tools, which results in cleaner cuts when cutting or punching into soft, sticky metals.

The CrN-HP coating can be used on tools made of most types of steel. Furthermore, the ductility of the CrN-HP coating makes it applicable to relatively soft base materials such as precipitation hardened aluminium types as well as various copper alloys.

Due to the high density, CrN-HP is the most suitable PVD coating for local corrosion protection of moulding parts.

CrN-HP can also be used as a substitute for hard chrome plating, thereby avoiding the use of environmentally hazardous hexavalent chromium (Cr^{+VI}). With its density and smoothness, the CrN-HP coating has a silver-like surface finish, which in combination with the hardness of the coating makes it usable as a decorative, scratch-proof coating for a number of exclusive products.



Cross-sectional SEM images of a CrN coating using traditional PVD technology (left) and a CrN-HP coating using HiPIMS technology (right). Note the characteristic columnar structure of the conventional CrN.

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DANISH TECHNOLOGICAL INSTITUTE

HiPIMS - the latest technology for industrial PVD coatings

Traditional PVD coating

PVD coatings can be made using several different methods. So far, the Tribology Centre has primarily used the so-called Magnetron Sputtering technique (MS) based on direct current (DC), the DCMS method. In a DCMS coating process, an electrical potential difference is created in the vacuum chamber between plasma and the raw material (e.g. chromium or titanium), from which the coating is formed. As the raw material (target) is subjected to a negative electrical voltage, positive ions from the plasma (e.g. Ar^+) will accelerate towards the target. This releases atoms from the target material as vapour. The evaporated material is then condensed on the surfaces to be coated and a PVD coating is formed. If the plasma also contains a reactive gas, e.g. nitrogen (N_2), it will react with the evaporated material, and a coating of e.g. chromium nitride (CrN) or titanium nitride (TiN) is formed.

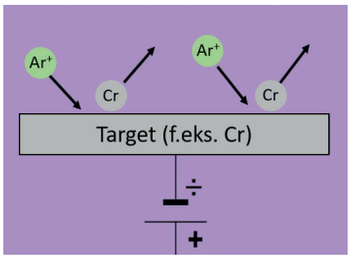

Fig. 1: Principle sketch of the conventional Direct Current Magnetron Sputtering (DCMS) process, which is based on a constant DC voltage between the raw material (target) and the plasma in the vacuum chamber enclosing the parts to be coated.

High Power Impulse Magnetron Sputtering (HiPIMS)

With a traditional PVD coating (DCMS), the target power is often significantly below 25 W/cm^2. However, in the new HiPIMS processes, much higher power is used in very short pulses (see Fig. 2). The mean power is about the same in the DCMS and HiPIMS processes, but the short, intense pulses in the HiPIMS processes provide a markedly different composition of the plasma. By the DCMS technique, mainly neutral atoms are detached from the raw material, whereas the HiPIMS technology forms far more electrically charged ions.

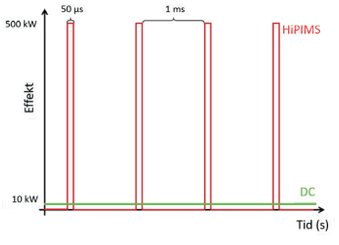

Fig. 2: The difference between the two processes; the conventional Direct Current Magnetron Sputtering (DCMS) and the new High Power Impulse Magnetron Sputtering (HiPIMS). In the example, there is about the same mean energy in the HiPIMS and DCMS process.

The higher degree of ionization in the HiPIMS processes makes it possible to create surface coatings with unique mechanical properties and completely different structures than is the case for conventional DCMS processes.

By changing the pulse lengths and/or the pauses between the pulses (frequency) and thus the energy per pulse, coatings can be developed with new and improved properties such as increased density, increased hardness and reduced internal stresses. Figure 3 shows an example of how the coating structure can be varied by changing the HiPIMS pulses.

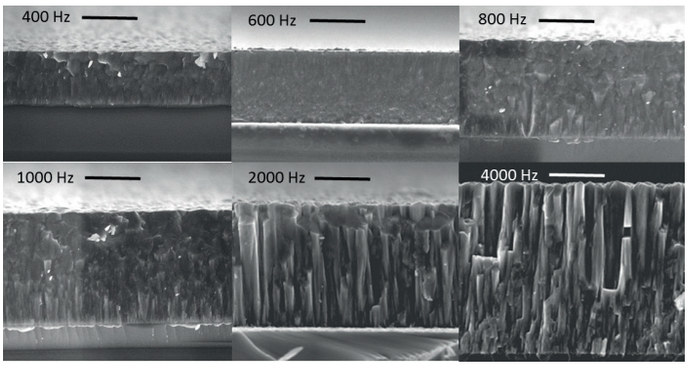

Fig. 3: Example of cross sections of coatings. The structure changes as the frequency of the HiPIMS pulses increases. The lower right image approaches conventional DCMS.

The Tribology Centre's new line of HiPIMS coatings has been optimized to provide coatings that are harder, denser and smoother. This has so far resulted in the coatings CrN-HP, Versal-HP and TiBto-HP.

The table below summarizes the differences between DCMS and HiPIMS.

Property	**DCMS**	**HiPIMS**
Percentage of electrically charged metal particles in the deposition process	Very low e.g. ~3% for chromium	Very high e.g. >70% for chromium
Density of the coating	Dense	Very dense
No. of defects in the coating	Few	Very few
Hardness	Hard	Harder
Even coverage of edges	Good	Better

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