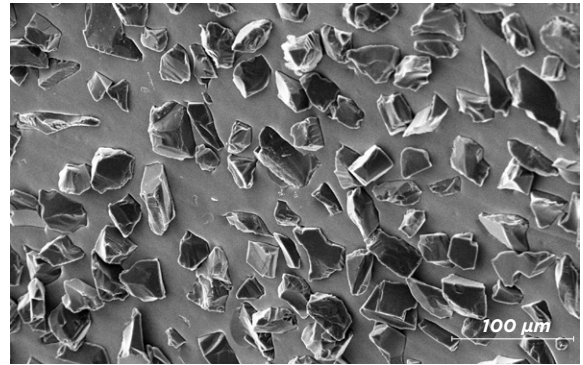


Friction-enhancing coatings

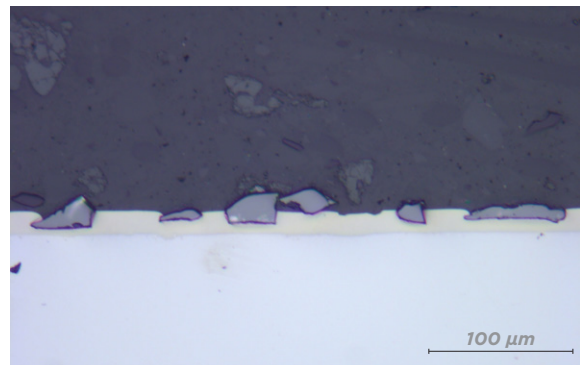
Electroless nickel-phosphorus coatings with embedded silicon carbide particles

Today's and tomorrow's requirements for efficient technical systems pose major challenges for engineers in all industrial sectors. For applications for frictional torque and force transmission, Aalberts Surface Technologies offers a reliable solution through targeted functionalization of the relevant surface areas. For this purpose, the nickel coatings with embedded hard particles, which are applied without external current (chemically), enable a significant increase in the resulting coefficient of friction between two contact partners, e.g. shaft-hub connection. In frictional connections, higher forces or moments can thus be transmitted without having to increase the surface area or the dimension of the components. On the other hand, while maintaining the requirements, a reduced component size is also possible, which in turn enables more compact designs and weight and cost savings.

The function of the frictional locking is ensured by the embedded silicon carbide (SiC) particles, which stick out from the nickel matrix and lead to a micro scale form fit in the attacking counterbody. Depending on the application conditions and basic and opposite bodies, friction coefficients of over 0.5 can be achieved in this way. At the same time, the incorporation of the SiC particles also increases the wear resistance of the coating.



SEM image of DNC® SiC 35 with recognizable nickel-phosphorus matrix and embedded silicon carbide particles

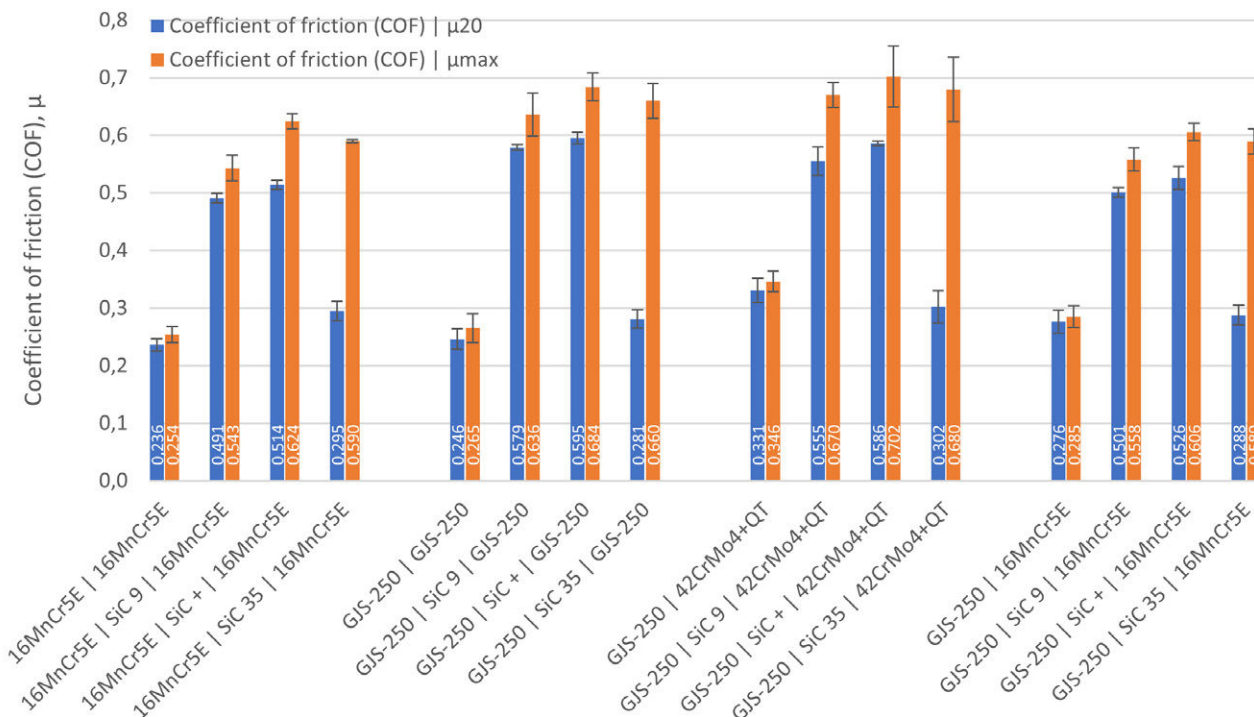


Cross section of DNC® SiC 35

Deposition is possible on all common metallic construction materials, and any pre-treatment steps or intermediate layers required for this are individually selected and coordinated. One advantage of metal deposition without external currents compared to galvanic processes is the uniform and almost geometry-independent layer thickness distribution, which is also maintained in this process variant. The silicon carbide particles used have a high hardness (up to 2,500 HV) and temperature resistance (up to almost 2000 °C). In addition, they are chemically very resistant even at high temperatures and are ecologically and regulatory harmless.

The coatings have already proven themselves several times over in various applications and industries and are applied by our specialists at the factory in Eindhoven according to the most precise pre-defined requirements for our customers. The plant in Eindhoven is also certified according to IATF 16949:2016 and ISO 9001:2015, among others.

Static friction coefficients for quasi-static torsion



By using the friction-enhancing coatings, friction coefficients between 0.5 and 0.7 are achieved, which corresponds to an increase in friction of up to 250% compared to without a coating.

Process variants and coating properties

The basic coating properties are given in the following table for the respective process variant. Our DNC® SiC coatings differ in particular in the average SiC grain size used, the resulting average occupancy density and other characteristics, e.g. achievable friction coefficients or requirements for tarnish resistance.

Property	DNC® SiC 9	DNC® SiC +	DNC® SiC 35
Coloration	silvery, grey, metallic to slightly shiny		
Composition	Nickel, phosphorus, silicon carbide (SiC)		
Phosphorus content	9 - 12 %		
SiC content (average occupancy density)	7 - 30 %		20 - 40 %
Mean SiC particle size [μm]	9	12	35
Hardness of Ni matrix [HV0.050]	570 \pm 50		
Layer thickness of the Ni-matrix [μm]	7 \pm 2	7 \pm 2	20 \pm 4
Operating Temperature	-40 bis 500 °C		
Other features	High coefficients of friction and wear resistance	Better tarnish protection due to modified Ni-matrix	High achievable coefficients of friction for ductile base materials

These studies were carried out in cooperation with TU Chemnitz (IKAT). The evaluation of the friction-increasing properties of the coatings is carried out by means of tests under quasi-static torsion and subsequent determination of the static friction values. The nominal surface pressure was 100 MPa and the quasi-static stress was carried out with a maximum rotation angle of 5 degrees (approx. 1 mm slip path). The tests were carried out on different material pairs, whereby the friction-increasing layer was applied to an intermediate disc.

From the obtained data and the resulting displacement at the mean diameter, displacement torsional moment diagrams (slip curve) were derived and parameters for the coefficient of friction μ were determined. The static friction coefficient μ_{20} indicates the coefficient of friction that occurs up to a relative displacement of 20 μm at the mean friction diameter (corresponding to 0.1° relative torsion). For the static friction coefficient μ_{max} , the maximum of the entire slip curve is taken into account.