Univ.-Prof.
Prof. h.c. (Moscow State Univ.)
Dr.-Ing. Dipl.-Wirt. Ing.
Thomas Gries
Head of Institute

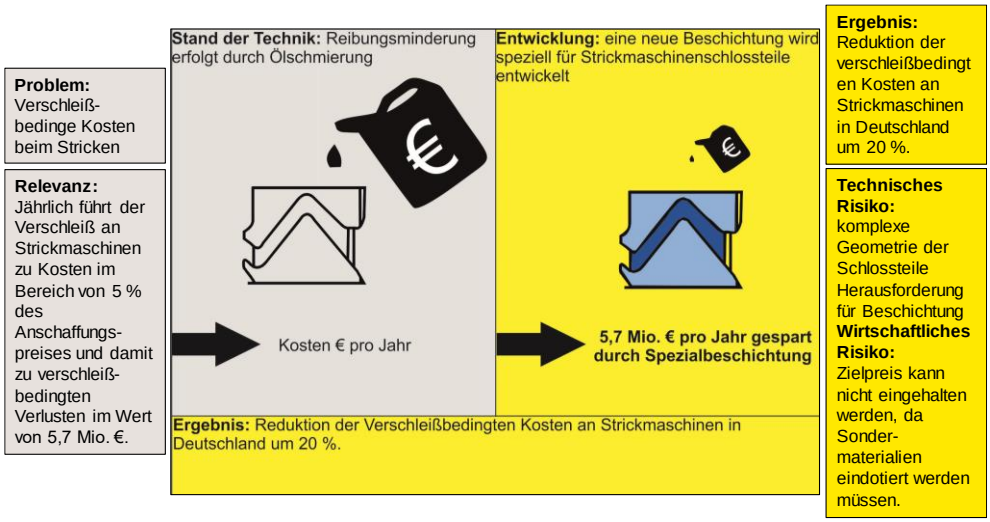
Lukas Lechthaler
Scientific Assistant

My Sign: LL

10.12.2018

Project title:	Development of friction-reduced, low-wear cam parts for knitting machines
Partner: S	AM Coating GmbH, Eggolsheim-Neuses
Running time:	10/2017 - 9/2019
Conveyor carrier:	ZIM

Central image of the ZIM project SAMStrick



Issue

Knitting is a highly productive process for the production of elastic textiles. The high dynamics of the knitting machines leads to high wear of the friction-loaded machine elements. Every year, the wear on knitting machines results in costs in the range of 5% of the purchase price of the knitting machines. These costs are caused by replaceable wear parts such as cam parts, needles and webs. In Germany, embroideries suffer a wear-related loss of around € 5.7 million every year. In order to keep wear and its follow-up costs low, knitting machines are currently lubricated with oil and the production speed is limited. The lubrication of knitting machines is particularly problematic for medical textiles. The use of lubricating oils requires a washing process of the knitted fabrics. Medical knitted fabrics made of sensitive yarns are often not suitable for laundries.

Goal and approach

Therefore, the aim of this project is to develop a novel, innovative combination coating that can guarantee wear protection and friction reduction at the same time. The aim of this coating is to ensure that lubricating oils will be largely eliminated from knitting machines in the future and that the wear of

elements such as the lock part will be minimised (Figure 1).

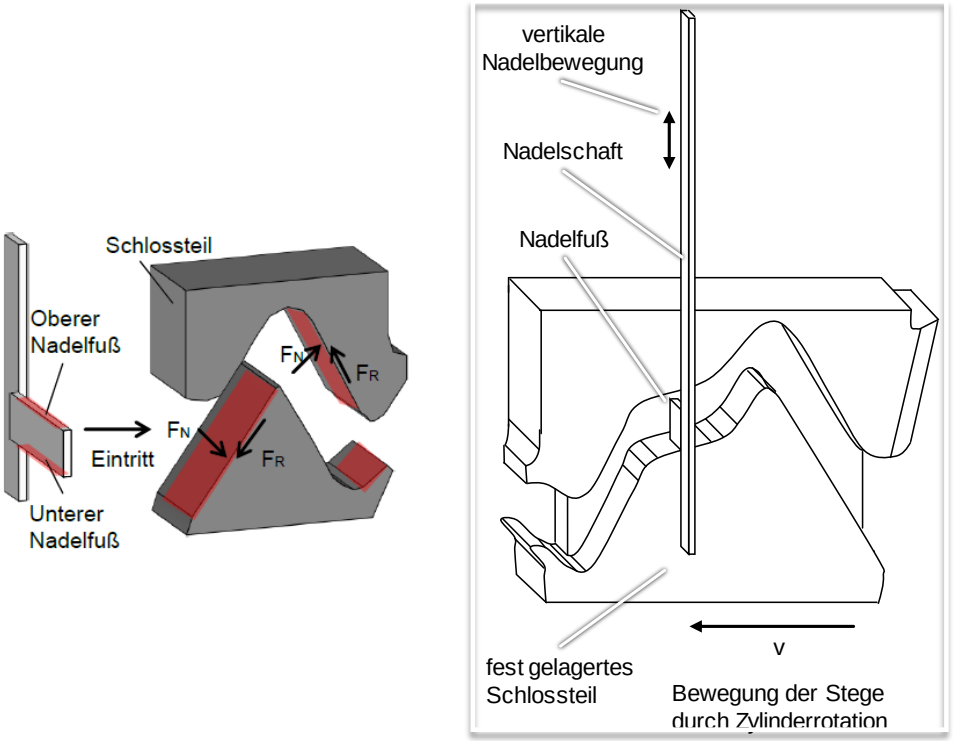


Figure 1 hochbelastete Flanken (links) und Nadelbewegung im Schlossteilkanal (rechts)

This will be realized within the project by combining the properties of a ta-C (tetragonal amorphous carbon) layer system with the properties of a tungsten-doped Diamond Like Carbon (W-DLC) layer system by SAM Coating GmbH. This is to be made possible by the construction of a combination layer.

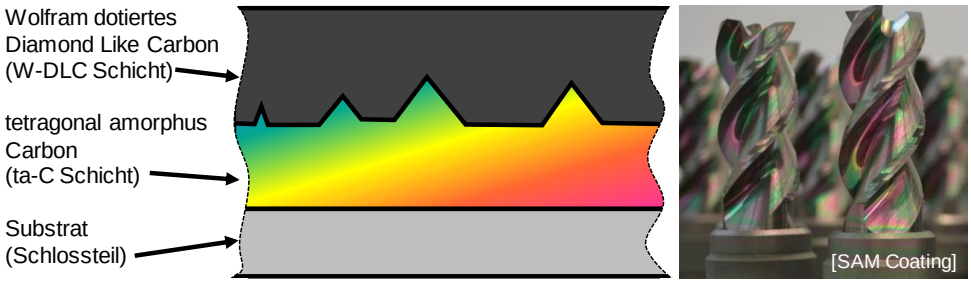


Figure 2: Schematic representation of the combination layer (left) and milling cutters coated with ta-C (right)

While the ta-C coating ensures a very high level of wear protection, the W-DLC and DLC coatings are predestined for applications with inadequate and dry lubrication. A combination of these coating systems or comparable approaches are currently not available on the market. The developed combination layer is tested and developed with regard to its friction properties under dry conditions and its wear resistance in endurance tests.

Economic significance & benefits

For SAM Coating a new market opens up after the successful completion of the project. Both knitting machine manufacturers and knitting mills can purchase coated lock parts for their machines from SAM Coating. Knitting machine manufacturers can equip and sell their knitting machines with the new technology. Knitting mills have the opportunity to reduce their annual wear-related costs.

Following the project, SAM Coating can also transfer the coating developed to new fields of application with comparable requirements. In particular, processes in which needles are in contact with metallic machine elements can be considered.

Solution

The extensive reduction of lubricating oils in knitting mills for medical knitted fabrics favours the processability of sensitive yarns, but currently leads to high wear. Low-friction hard coatings, such as the ta-C coating from the automotive sector, also function in dry environments. With targeted coating development, the surface proportion of the bond structures of sp2 (graphite) and sp3 (diamond) can be specifically adjusted. A novel coating is being developed for knitting machine lock parts. The new coating will be tested and designed for its friction properties under dry conditions and for its wear resistance in endurance tests. The aim of the coating development is to reduce the wear-related costs of knitting machines in Germany by 20 %. In addition, the heat generated on the knitting machine due to wear is reduced by 10 °C. The coating development is also designed to reduce the wear costs of knitting machines in Germany by 20 %. A tribological knitting test stand is used to test the coating. The friction can be quantified on the knitting test stand by measuring the torque. Wear is quantified by optical measurements and measurements of surface roughness and roughness depth. For the measurement of the oil requirement, a test plan is developed in which different coating variants and uncoated lock parts are measured on the test bench with different doses of oil supply. The torque is recorded. The suitability of the coatings is evaluated on the basis of the lock parts by an optical evaluation, by analysis of the torque and by analysis of the surface. Iteratively, the coating system is adapted to the application.

For use in the machine, a field test is carried out in a machine. The permanent usability of the coated lap parts in the knitting machine is decisive for the reduction of wear costs. The suitability for permanent use depends on the coating thickness and the adhesion of the coating to the cam part. Here the complex geometry of the lock parts for the coating is a risk and a challenge. The geometry of the lock curve in knitting machine lock parts requires coating of 90° inner edges. For the coating, the cam parts have to be additionally hardened. Residual stress-induced stress peaks occur at the edges of the coating. If the residual stresses of the material are superimposed on the residual stresses of the coating, the durability of the coating can be reduced. Therefore, the coating must be examined and adapted with regard to

its adhesive properties on the lock part, taking into account the residual stresses.

Acknowledgements

The ZF4018786CJ7 research project of AiF Projekt GmbH, Berlin is funded by the German Federal Ministry of Economics and Energy as part of the Central Innovation Program for Small and Medium-Sized Enterprises (ZIM) on the basis of a decision by the German Bundestag.