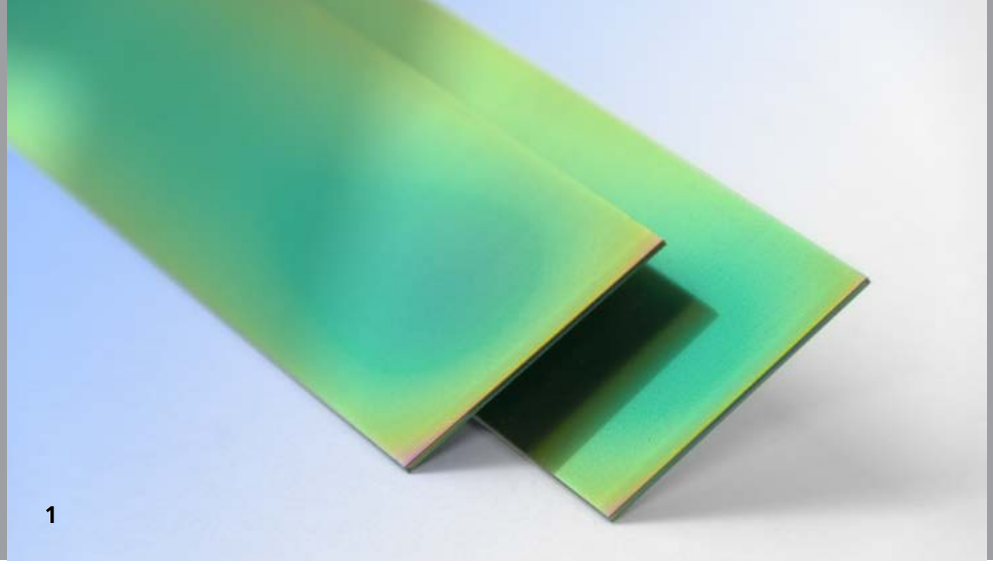

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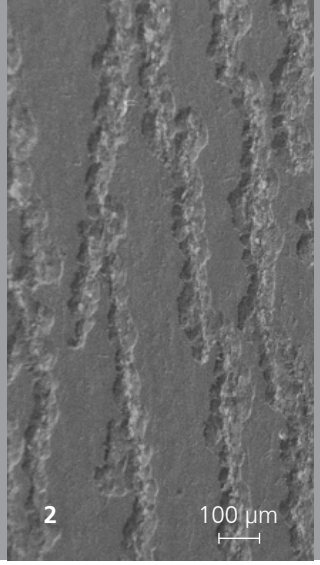

2

NEW MANUFACTURING APPROACH FOR ANTIFOULING COATINGS FOR PIPES

The formation of deposits on technical surfaces, also called fouling, interferes with the functioning of process plants, reduces productivity and impacts on product quality. Especially in the case of heat-transferring components the deposits also raise energy consumption while simultaneously lowering efficiency. New antifouling strategies with non-stick coating systems can for this reason yield considerable cost reductions in the chemical, pharmaceutical and foodstuffs industries. Together with partners from Belgium and Germany the Fraunhofer IST has developed a new approach to manufacturing pipes with an antifouling coating on the inside of the pipe.

Damage due to fouling

Problematic deposits arise in numerous systems from different mechanisms, such as, for example, crystallization, particle or bio-fouling. Calcium deposits, such as boiler scale, are ubiquitous in components carrying water. Fouling in heat exchangers affects not only the flow but heat transfer in particular. The consequences range from lower energy efficiency to complete loss of function. In sensitive areas, such as the manufacture of medicaments, the presence of deposits is often not acceptable.

Antifouling strategy: coating systems with low surface energy

Conventional measures for reducing deposits include a careful selection of the materials and media used or compromises in the process technology. Both approaches mean restrictions on the design of production facilities and additional costs. Further outlay arises from mechanical and/or chemically-acting cleaning procedures to remove deposits and keep components in good maintenance.

The approach taken by the Fraunhofer IST is to use anti-adhesive coating systems to counteract the formation of deposits. Modified DLC coatings (diamond-like carbon), such as SICON® – a coating of hydrocarbon modified with silicon and oxygen – are particularly promising here since not only do they have anti-adhesive functional properties but also a high degree of hardness and durability.

SICON® and other plasma-chemically deposited coating systems with low surface energy are already in successful use in many applications at the Fraunhofer IST for preventing adhesions. However a broad application in process engineering calls for coatings inside heat-transferring components, for example, on the interior of pipes. Direct coating of the inner walls of pipes is only possible to a limited extent with PACVD and PVD processes and in many cases does not deliver the coating quality required.

New manufacturing approach for internally coated pipes

A new approach to manufacturing has therefore been developed in collaboration with experts in forming and welding technologies. Here flat steel sheets are coated and then

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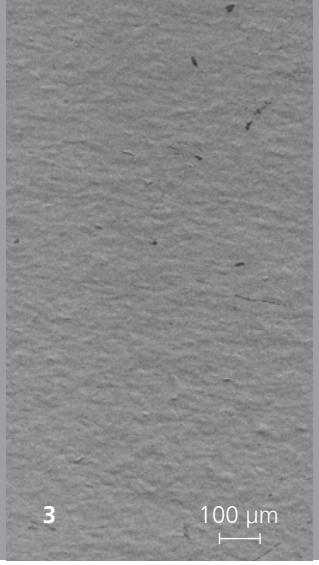
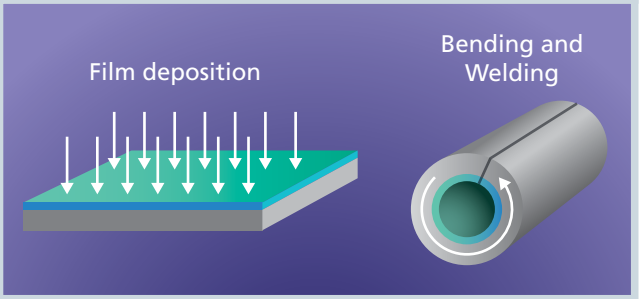


formed into pipes and welded (see sketch below). The coating must not suffer any damage during roll-forming of the pipes, its antifouling function must be guaranteed and it must have a high degree of durability. Currently pipes over a meter long can already be produced with an anti-fouling coating on the inside (Fig. 1). Appropriately adjusted PACVD processes mean that modified DLC coatings can be produced which remain entirely undamaged even with small pipe diameters (currently tested down to 12 mm) (Figs. 2 and 3).

Outlook

The effectiveness of the coating systems developed has already been demonstrated for various fouling mechanisms. Formation of deposits can be markedly reduced or even entirely prevented by SICON® coatings. Pipes more than one meter long and manufactured in the way we have described are at the present time being investigated and evaluated in special fouling-tests. In the future, complete heat transfer systems with piping provided with an anti-fouling coating on interior surfaces are to be built. Prototypes are to be trialed in particularly challenging production processes in process engineering.

Manufacturing approach for pipes with an antifouling coating on the inner wall.



1 *1 m long metal stripe with antifouling coating before role-forming.*

2-3 *Different coating systems on the inside of the pipe after the forming process: (2) Standard DLC coating shows damage due to the pipe-forming process, (3) Modified DLC coating is fully intact and functional even after pipe forming.*

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