As fast as a shark in water

December 15 2006

With the help of tiny ridge-like structures in their scales, sharks are able to minimize drag when swimming. A new coating system takes advantage of this “riblet effect” to improve the aerodynamics of vehicles and aircraft.

Scales have a beneficial effect on the speed at which fish swim: tiny ridges arranged parallel to the swimming direction, known as “riblets”, reduce drag in water. This riblet effect, which has been known to scientists and engineers for more than 50 years, can also be utilized by ships and other means of transport: Films with a suitable structure can be applied to their outer surfaces to reduce frictional resistance and thus bring down fuel consumption.

The problem is that these films can only be applied to flat or convex surfaces, but bodies whose aerodynamic or hydrodynamic properties have been optimized tend to have a more complex shape. The alternative to coating with a film is to texture the surface itself with riblets. However, none of the laser or milling techniques which have been employed so far are suitable for components that have to be painted, as the paint would immediately flow into the tiny grooves and fill them.

Dr. Volkmar Stenzel of the Fraunhofer Institute for Manufacturing Engineering and Applied Materials Research IFAM (Germany) thus came up with the idea of integrating the riblet pattern into the lacquer itself. “That meant we had to look for a tool which didn’t adhere to the lacquer, so that it could impress the required structure onto it,” explains Stenzel. A prototype has now been created, combining a suitable lacquer

and the technology for applying it. The novelty is that an approximately 20 cm wide transparent silicone film with a riblet pattern serves as a “stamp”. This is capable of printing patterns with a resolution of a few nanometers, similar to those found in holograms, onto surfaces. The film runs over three flexible rollers and can thus adapt its shape to hug uneven surfaces. From the front, a new type of resin lacquer is continuously sprayed onto the film and transferred with the help of the rollers onto the surface to be treated. A UV lamp then hardens the resin in a fraction of a second. Because of the extremely fast application and hardening process, the riblet structure is retained.

“Our trial lacquer is based on the chemistry used in aviation paints. It is mechanically very durable and,” Stenzel hopes, “should also be resistant to strong UV radiation at high altitude.” A field trial will soon show whether the lacquer fulfills its promise in practice. However, applications for the new coating system are not restricted to the aviation industry, as Stenzel stresses: “With this technology we can apply any other micro and nano structures to lacquered surfaces.”

Source: Fraunhofer-Gesellschaft