Determining toothpaste abrasion

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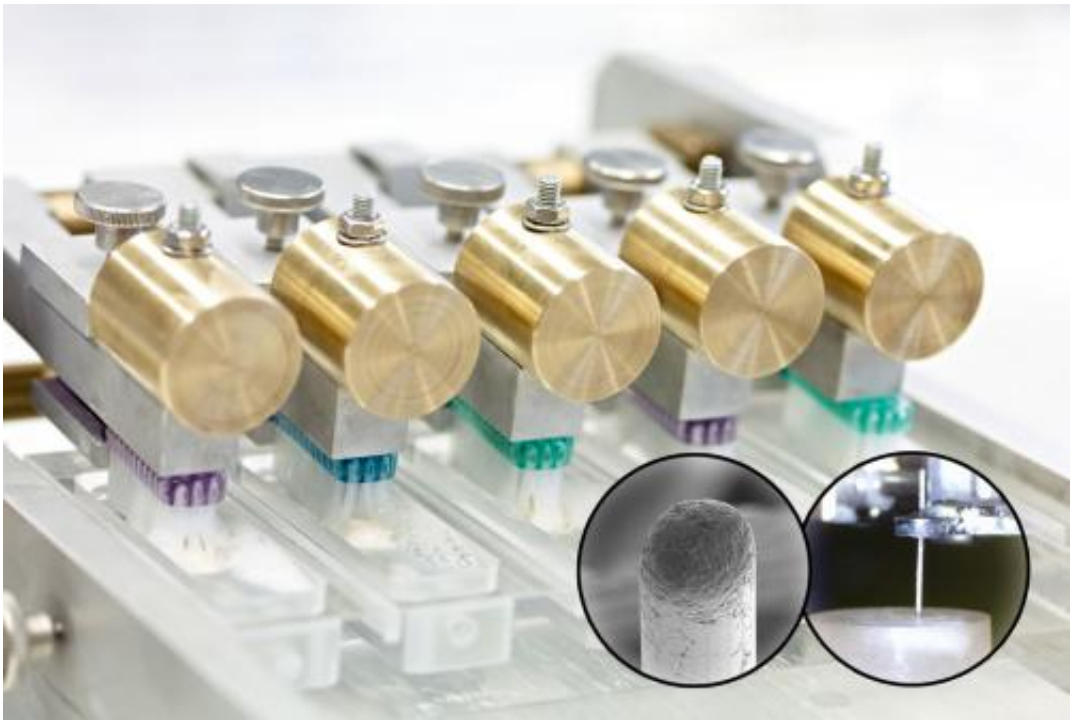

Researchers intend to supplement their microtribological analyses of the interaction between toothbrush, toothpaste and tooth surface with practical tests, using a tooth cleaning machine they have developed themselves. Bottom right: Friction and wear tests with individual bristles. Credit: Fraunhofer IWM

There are various types of toothpaste available on the market. They come as pastes and gels, there are some that guard against tooth decay or protect teeth from acid attack, others that are designed for sensitive teeth. But which toothpastes clean well? Which preserve the tooth enamel? A new evaluation method sheds light on the subject.

Everyone wants to have beautiful teeth. After all, a perfect set of teeth symbolizes health and youthfulness, and can even influence career prospects. If having pristine teeth calls for thorough oral hygiene, then how well or badly does a given toothpaste clean? How effective is it? What should it contain in order not to damage the structure of the teeth? Such questions are primarily of interest to manufacturers of dental hygiene products, and answers are being delivered by researchers from the Fraunhofer Institute for Mechanics of Materials IWM in Halle. Through close collaboration with the Microtribology Centre µTC in Karlsruhe they have developed a new process for testing the abrasive effect of toothpastes, allowing this 'abrasivity', as experts call it, to be compared and evaluated in the lab.

Dangerous abrasive effect

Cleaning particles are an important component of toothpastes. These abrasives, as they are known, mechanically remove dental plaque. Nevertheless, the paste should not be too strongly abrasive. Over the years the abrasion can cause damage to the tooth enamel, which does not regenerate itself. This damage is more visible and pronounced in the soft dentin. The German Dental Association recommends that people choose less abrasive toothpaste if the necks of their teeth are exposed.

The abrasive effect of a particular toothpaste on tooth dentin depends on the hardness, amount and particle size of the abrasive additives it contains, such as silica or alumina. Abrasivity is measured as the RDA value (radioactive dentin abrasion), ranging from 30 to over 200. This value is determined via a complex process that involves testers brushing over radioactively marked dentin samples. The abraded material is then measured via the resultant radiation intensity of the toothpaste slurry. Not all experts agree on the validity of RDA values, as test results have been known to vary partly from lab to lab.

Determining abrasion rates with microtribological tests

The researchers at the IWM have chosen an alternative method to this radiotracer system. "Our new approach enables us to determine realistic abrasion rates and characterize the interaction between brush, enamel and toothpaste. What's more, our tests are less laborious than the time-intensive radiotracer procedures carried out by only a handful of laboratories worldwide", says Dr. Andreas Kiesow, team leader at the IWM. The scientist and his team have successfully managed to determine the abrasion of various toothpastes on a microscopic scale and to measure the friction values using microtribological experiments. "Until now, tribological values such as friction coefficient, did not exist" says Kiesow.

The researchers use human teeth as well as different toothpastes made by industrial partners for their experiments. These toothpastes were diluted with water and saliva in order to create a solution whose consistency corresponds to the mixture of toothpaste and saliva that is present when people brush their teeth. The friction and wear tests were each carried out with a single bristle – referred to as a monofilament. This is mounted in specialized tribological instruments, a microtribometer and a nanoindenter, and moved over the sample in both straight and circular motions, in the latter case up to 8000 times. Highly sensitive instruments then measure the depth of the resultant marks left on the surface of the tooth. "Our findings reveal that the RDA value of toothpastes correlates with the depth of abrasion; the higher the value, the greater the abrasion. By analyzing the friction value we also identified a clear relationship between the friction behaviors of the bristle on the dental enamel and the abrasiveness of the toothpaste", sums up Kiesow. The new process allows the researchers to not only characterize the abrasion more quickly and simply, but also to describe

how different geometries of toothbrush filaments act upon the surface of the tooth and how the bristle shape should ideally be designed. The experts at IWM can use their know how to support manufacturers of dental hygiene with product development. At the end of the day it is the consumer who benefits most.

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