Developing dental restorative and prosthetic materials that look more natural, last longer, and function better is becoming easier thanks to research at Penn Dental Medicine.

“Right now is an exciting time for restorative dentistry and prosthodontics with the rapid advancement of digital dental technologies,” says Dr. Markus Blatz, Professor and Chair of the Department of Preventive & Restorative Sciences, who is at the forefront of testing the application of computer-assisted design and manufacturing (CAD/CAM) and 3-D printing in restorative dentistry. He is the founder of Penn Dental Medicine’s CAD/CAM and Ceramic Center.

**BRINGING NEW TECHNOLOGIES ON BOARD**

Bridging the gap between clinical dentistry and dental material science, Dr. Blatz and his colleagues examine the physical, optical, and biological properties of new dental materials, especially ceramics and adhesives, with the aim of creating more natural-looking restorations and less-invasive solutions. They collaborate with schools and facilities across Penn, like the Singh Center for Nanotechnology.

“With current CAD/CAM technologies, we can manufacture and apply the whole spectrum of dental materials—from metal alloys like we’ve used in the past, to modern polymers and ceramics,” Blatz says. “We’re not limited to just a few materials with this technology.”

Until recently, dentists and technicians needed a physical mold of the patient’s teeth to fabricate implant- or tooth-supported prosthetic restorations. Now, they can use a digital image of the teeth or implants captured by an intraoral scanner to design these restorations on the computer and fabricate them, quickly and precisely, via milling or 3-D printing. This “digital workflow,” combined with an ever-evolving variety of new materials, has the potential to save dentists and patients time and expense—and may open up new restoration possibilities for patients who didn’t have many options before.

**MAINSTREAMING DIGITAL DENTISTRY**

Individual dental practices have been a bit slow to adapt to digital technology and new materials, but Dr. Blatz believes Penn Dental Medicine can help show them the way: “There is a lot of misinformation out there. One of our roles is to help dentists and technicians understand new materials and technologies and how they can benefit clinicians and their patients.” He and his colleagues fill a vital role as a test kitchen, exploring promising applications identified by industrial scientists and communicating their findings to the dental community.

*Continued*
NEW OPTIONS FOR A FULL SMILE

Dr. Blatz enjoys seeing the impact of new materials and digital methodologies that are used chairside and in the dental laboratory to create better restorations. “For me, research is only meaningful if it can help our patients,” he says. “In this work, I can see patient outcomes pretty directly.”

He recalls one woman who had to wear a removable partial denture to replace some missing front teeth. Dr. Blatz’s team provided her with CAD/CAM-fabricated bridges that were bonded to her existing teeth. “Before, she thought she’d have no option but to either grind the teeth down completely or have implants placed, which is a cost-intensive surgical procedure,” Dr. Blatz says. “These are the things that really make our work worthwhile.”

His department’s new prosthodontics specialty program, started in 2017, incorporates the full breadth of digital dentistry, from using intraoral scans to the digital design of restorations to the milling of new crowns, dentures, or bridges. Thanks to a foundation grant, Penn Dental Medicine students can use haptics technology and 3-D virtual reality to simulate patient procedures like tooth preparation and tooth cutting. Soon, Dr. Blatz believes, students will be able to practice almost anywhere with novel haptics devices, “Maybe even in their own living room!”

MINIMALLY INVASIVE DENTISTRY

Prostheses like bridges and crowns often require cutting down the affected or neighboring teeth, but the right materials can reduce the invasiveness of this procedure. For instance, CAD/CAM-fabricated composite or ceramic inlays, onlays, and veneers can be bonded directly to the teeth, which requires composites, primers, and adhesives that can withstand the force of chewing and the environment of the mouth without degrading. Dr. Blatz’s lab is leading development of these materials, working with several dental manufacturers.

“Dental materials change very quickly, and federal funding for dental materials and restoration research is somewhat limited,” he says, “Collaboration with industry and with donors is extremely important.”

A DISTINGUISHED ENVIRONMENT

Penn Dental Medicine enables Dr. Blatz to work at the nexus of medicine, academia, and industry, and to influence dialogue across sectors—and across the globe.

“We are well known internationally in clinical circles for the work that we do and also for providing unbiased research. We have gotten a global reputation as among the leaders in CAD/CAM ceramics and bonding,” says Dr. Blatz, who conducts research with a network of colleagues in Japan, China, Brazil, Germany and other countries. He co-founded the International Academy for Adhesive Dentistry, which had its second meeting at Penn in June 2017. The goal, Dr. Blatz says, is “to reach as many colleagues, dentists, and definitely as many patients as possible.”

MORE INFORMATION

For more information on how to support the research of Dr. Blatz, contact Elizabeth Ketterlinus, Senior Associate Dean for Development & Alumni Relations, ekett@upenn.edu, 215-898-3328.