
3M
Filtek™
Dental Restoratives
Nanoscale dentistry. Big results.
Take a closer look at 3M's nanofiller technology and the future of dentistry.

As modern dentistry has developed a deeper understanding of the tooth, its structure and patterns of wear, our methodologies for preservation and repair have advanced exponentially. When nanotechnology – the direct manipulation of materials at the nanoscale – was first applied to dental fillings, it changed the landscape of dentistry as a whole.[1] Now, 3M™ Filtek™ Universal Restorative represents the next step in dental nanocomposites: the meeting of two groundbreaking technologies that work together to prevent shrinkage stress, and to give patients strong, esthetic fillings – all with a streamlined procedure.

The history of dental fillings and nanofillers

Our collective efforts to repair damaged teeth have come a long way: from ancient examples of teeth filled with bitumen, plants and beeswax, to the potentially harmful alloys of the 17th Century, all the way to our modern amalgams and composite resins.[2,3] However, no development has done as much for strength and esthetics than the addition of nanoparticles.

Before the mid-1990s, dental filling materials were limited. Nothing available was simultaneously esthetic and strong enough to withstand daily wear, leading to complications down the line. Enter Dr. Sumita Mitra, a chemist with 3M Oral Care. In the late 1990s, Mitra, along with a team of researchers at 3M, worked to develop the first dental filling material to include nanoparticles.[4]

The innovative nanocomposite, comprised of a combination of nanomers and nanoclusters, displaced the existing 100-year-old technology and changed the landscape of dentistry. The new technology took advantage of nanoparticles' small wavelengths, which produced a smoother appearance, and high strength to achieve never-before-seen results that were both highly cosmetic and durable.[7]

Since Mitra's breakthrough, nanomaterials have found other applications in dentistry. 3M's nanocomposite technology also continues to evolve, under its trusted Filtek brand name. The latest development: a universal composite harnessing both high-strength nanotechnology and low-stress monomers.

A brief history of dental fillings[2-6]

11.000 BCE
Evidence of bitumen and plants used to fill cavities discovered in Northern Italy

700 AD
Chinese medical text mentions the use of a "silver paste," or amalgam filling

Early 1800s
Repeated instances of "exploding" teeth, theorized to be the result of multiple metals used in fillings reacting in the mouth[6]

4500 BCE
Ancient cavity filled with beeswax found in Slovenia

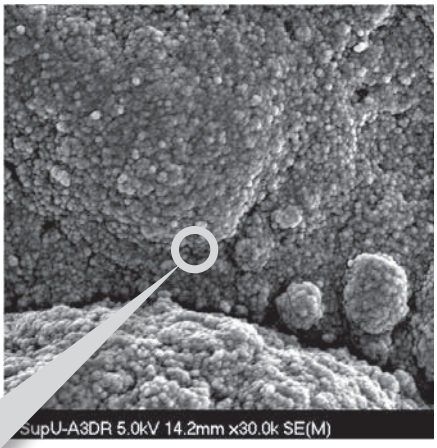
1530
First dentistry book published in Germany and includes instructions for gold filling placement

1819-1850
Mercury-based dental amalgam fillings are invented and widely used, leading to controversy over the health effects

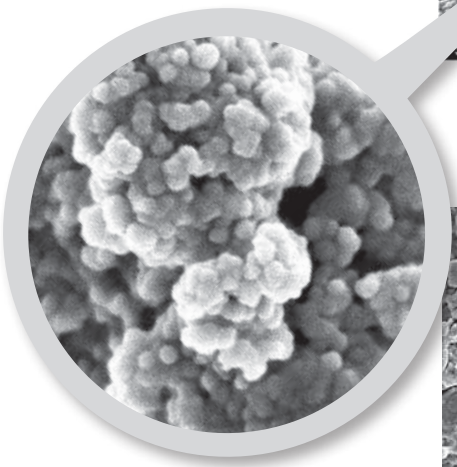
TRUE nanofiller technology

Today, dentists have more choices of filling materials than ever. Dental composites have become especially popular due to their translucency, esthetics, direct-filling ability and enhanced performance. However, not all composites are created equal. Micro- and nanohybrid composites are the result of grinding, resulting in a broad range of particle sizes that wear inconsistently over time. While hybrids may allow for high filler loading and strength, the diversely-sized particles ultimately limit the composite's overall esthetic abilities. When the resin wears down, the larger particles protrude and fall away, leaving craters that lead to a rough, unpolished surface.[8]

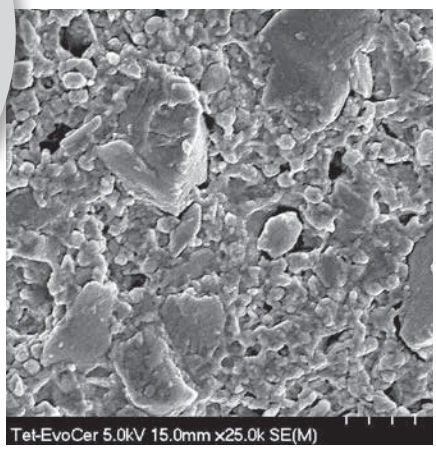
TRUE nanocomposites, such as in 3M™ Filtek™ Restoratives, are uniquely formed from evenly-sized, sub-100 nm particles that mimic natural enamel. The uniform particles wear at a rate similar to the rest of the tooth, creating a more natural, polished appearance that can even improve with regular brushing.[9] And because it's possible to manipulate the material at the nanoscale, the nanoparticles can be fused into loosely agglomerated clusters – providing the high filler loading of a hybrid. Unlike hybrid composites, however, the nanoclusters also deliver a combination of strength, wear resistance, gloss, polish retention and esthetics that cannot typically be achieved with traditional types of filler technologies.



3M™ Filtek™ Restorative nanocluster



100K magnification of nanocluster



Leading competitive composite

1962
Rafael Bowen develops the Bis-GMA monomer, a thermoset resin complex used in modern composite resin restorative materials

1980s
The first microfill composites are developed, which offer excellent esthetics but low strength

1949
Oskar Haggar develops first system of bonding acrylic resin to dentin

1970s
First light-cured, macrofill composites are introduced and are strong but difficult to polish

1990s
Hybrids, a mix of two or more epoxies, and composite layering become popular

1998
Sumita Mitra and a team of researchers at 3M develop the first nanocomposite

Dual endurance monomers

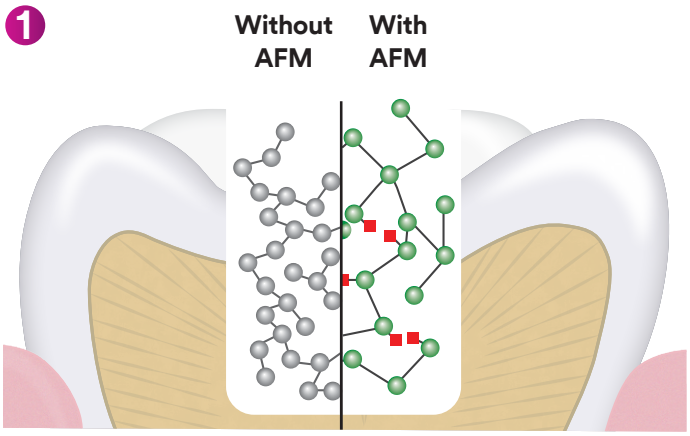
Shrinkage stress is often overlooked in universal composites, but it can have a dramatic effect on the clinical success of restorations. During the polymerization process, methacrylate resin composites undergo some amount of dimensional shrinkage which, when restricted by bonding to cavity walls, can put stress on the tooth structure. This stress can result in gaps, marginal staining, recurrent caries, hypersensitivity or even fractures in the tooth.[10]

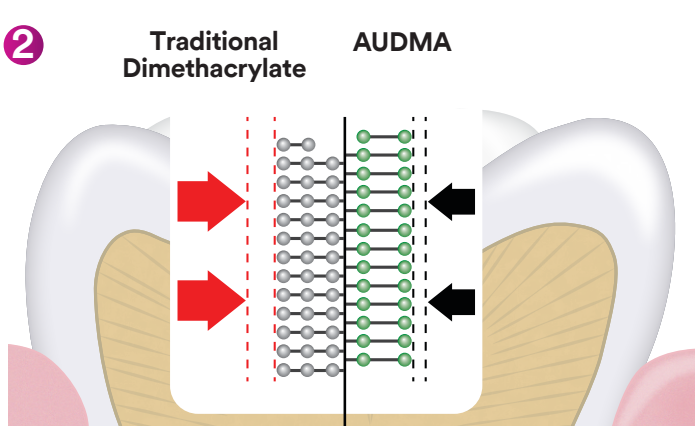
Filtek Universal Restorative features a revolutionary dual endurance resin system containing two innovative methacrylate monomers designed to lower polymerization stress:

- **Addition-Fragmentation Monomer (AFM)**
  Like any methacrylate, AFM develops into a polymer matrix during the curing process. However, it contains a unique third reactive site that fragments during polymerization, allowing the network to reorient into a more relaxed position – providing stress relief while maintaining the physical properties of the polymer.

- **Aromatic Urethane Dimethacrylate (AUDMA)**
  This large, high molecular weight monomer decreases the number of reactive groups in the resin, limiting shrinkage zones, moderating stiffness and reducing stress during polymerization.

These unique monomers work together along with 3M's patented nanotechnology to reduce polymerization stress, maintain wear resistance, and deliver excellent esthetics. Together, they comprise an effective solution for both esthetic anterior and long-wearing posterior restorations.[11]

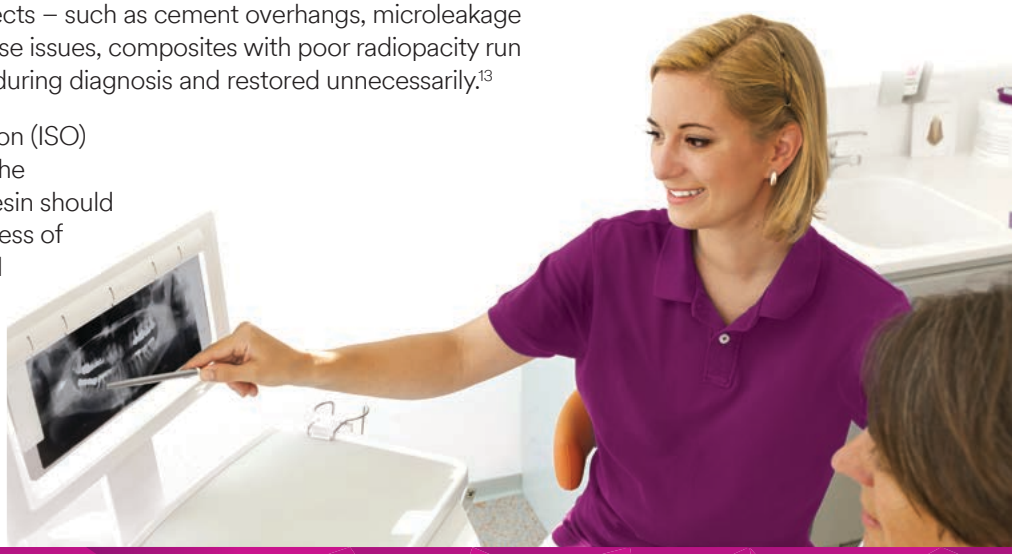




Radiopacity

Radiopacity is the inability of radiation, such as an X-ray, to pass through a particular material, resulting in an opaque image. Adequate radiopacity is required in dental restorative materials, as it allows dental professionals to distinguish between the material and surrounding tissue to spot defects – such as cement overhangs, microleakage or interfacial gaps.[12] In addition to disguising these issues, composites with poor radiopacity run the risk of being confused as secondary caries during diagnosis and restored unnecessarily.[13]

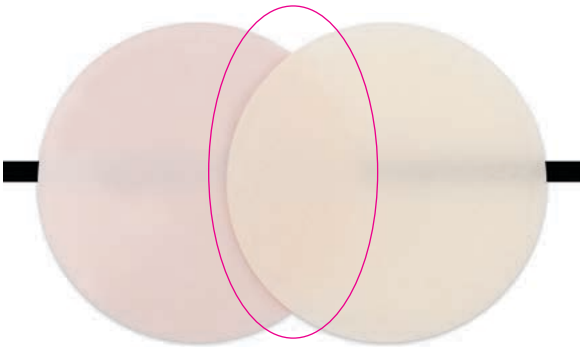
The International Organization for Standardization (ISO) and American Dental Association specify that the radiopacity of a 2 mm thick dental restorative resin should be equal or greater than that of the same thickness of aluminum.[14, 15] The radiopacity of Filtek Universal Restorative is 250-260% of aluminum – well above the standard required to maintain and evaluate restoration quality.



NaturalMatch Technology

Modern dental patients expect restorations to look just like their natural teeth, but achieving highly esthetic results while staying on schedule isn't always easy. Restorations can be complex and time-consuming, even before color-matching – it's one reason most dentists use a single shade for 80% of their restorations.[9]

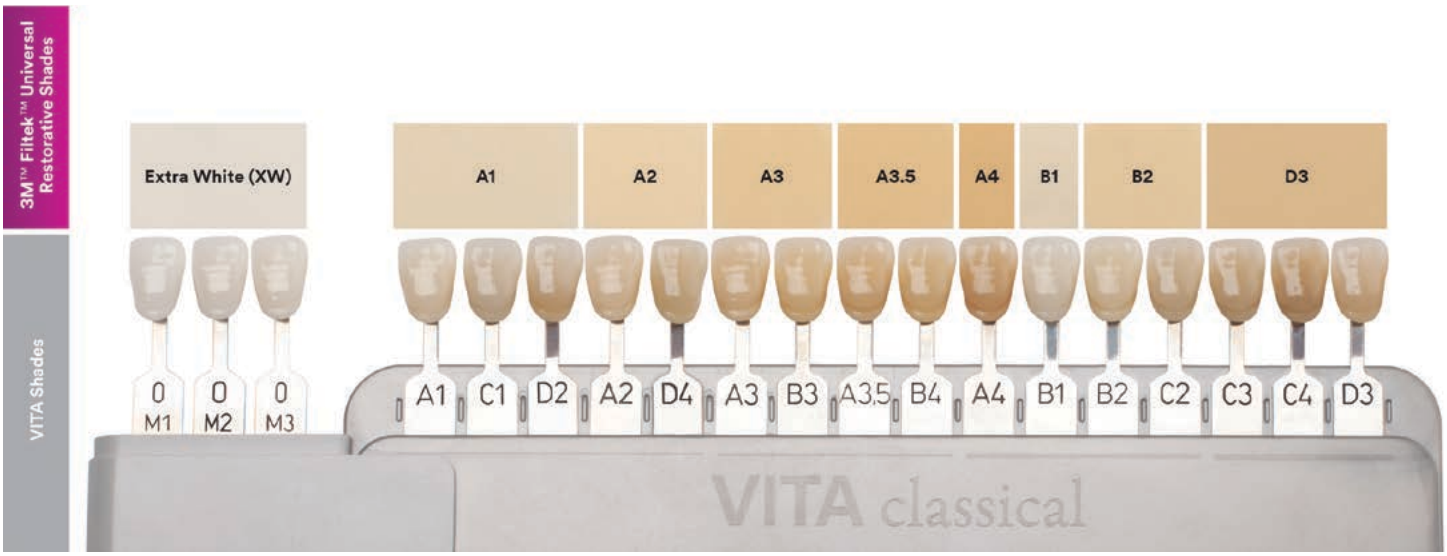
Filtek Universal Restorative was engineered to make highly esthetic, single-shade restorations easier. The secret: NaturalMatch Technology, a unique blend of 3M's nanotechnology, low-stress monomers and pigments designed for a natural match to dentition. Using only eight designer shades plus an Extra White (XW), Filtek Universal Restorative covers all 19 VITA classical and bleach shades.[9] The pigments selected are based on the VITA classical and bleach shades for optimal shade coverage and a natural blending effect. Filtek Universal Restorative's unique formulation also features fluorescent pigments to match the lifelike light absorption and emission properties of natural dentition. And in light of the growing popularity of tooth-whitening, 3M has modified the pigment formulation and composition of Filtek Universal Restorative to provide a "whiter white" (XW) capable of matching extra white bleached teeth.



PO/A1

Dark line effectively covered by PO and A1

In addition to our NaturalMatch Technology, 3M simplified the process further by selecting a universal opacity. Situated between dentin and enamel, the universal opacity is neither too opaque nor too translucent to meet most clinical needs and help blend almost invisibly with surrounding dentition. This balance enables single-layer restorations in both the anterior and posterior of mouths. What about those times where stained dentition, metal or dark areas need a bit more coverage? That's where 3M's Pink Opaquer (PO) comes in. Applied up to a 1 mm layer under a Filtek Universal shade, this pink opaquer effectively masks dark spots, metal, stains, and port access holes, enhancing and improving restorations for excellent esthetic results.[9]



Conclusion

In restorative dentistry, the smallest details make a big difference – such as a filling that even close friends can't spot. That's why 3M's newest dental composite is designed at the nanoscale. Optimized for both esthetics and efficiency, Filtek Universal Restorative is the culmination of a history of innovation and a demonstration of 3M's commitment to improving the field of dentistry for clinicians and patients alike.

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