Inside Nanotechnology

How 100% nanofiller technology is different, and why it results in better wear and polish retention.

Advancing technology has created better composites, but can also create confusion about the differences between them. This article looks beneath the surface—at the particles—where it all starts.

Micro- and Nanohybrids: strength and wear resistance

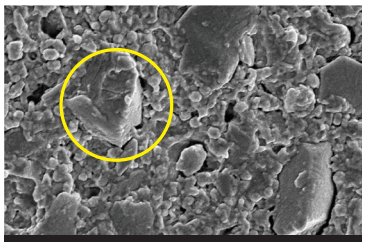
Hybrids (*e.g., TPH3, EsthetX HD, Premise, Herculite Ultra, Grandio*) contain a broad range of particle sizes (Fig. 1) which allows for high filler loading, and results in strength and wear resistance—but diminished polish retention.

The distinction between microhybrid and nanohybrid composites is not clear. Most are made by producing a glass which is then crushed into a range of sizes—the largest can be greater than 1 micron (10 times greater than the primary particle size of a microfill or nanocomposite). When these hybrid composites are subject to abrasion, such as toothbrush abrasion or chewing, the resin between the particles is worn away, leaving the larger filler particles protruding above the surface. Eventually, the entire filler particle is plucked from the surface, leaving craters. The protrusions and craters create a rough surface, loss of reflectivity and decreased polish.

It is common for manufacturers to add nano-sized particles (particle sizes sub 100 nanometers) to composites marketed as microhybrid and nanohybrid composites. These smaller particles fill in the gaps between the larger, ground filler particles. There is a limit to the amount of nano-sized particles that can be added before the handling of the paste is negatively impacted. In both of the hybrid composite types, the larger ground particles ultimately limit the composite's overall esthetic capabilities.

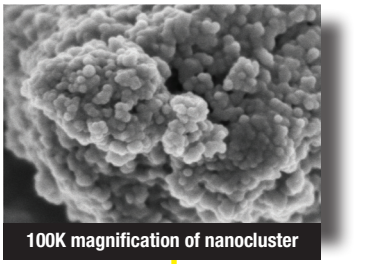
Nanocomposites: excellent strength, wear resistance and esthetics

Nanocomposites (*e.g., Filtek™ Z350 XT Universal Restorative*) contain 100% nanofiller, which means the primary particles are below 100 nanometers (nanoparticles). These primary particles are formed in the nano size range and are not the result of a grinding process. Some nanoparticles of Filtek Z350 XT restorative are fused into secondary structures called nanoclusters. (Fig. 2) Nanoclusters have a similar size range as fillers found in the hybrid composites, therefore they provide for high filler loading. This results in optimum physical properties and wear resistance (Fig. 3), making it excellent for posterior restorations. The significant distinction between Filtek Z350 XT restorative and micro- and nanohybrids lies in the nanocluster. Unlike the ground filler of micro- and nanohybrids, the nanoclusters retain characteristics of the primary nanoparticles from which they are derived. So under oral challenges such as toothbrush abrasion, the wear rate of the nanoclusters is similar to the wear rate of the surrounding resin matrix—which means the nanocomposite maintains a smooth surface gloss better than the hybrid composites, (Fig. 4) giving restorations unsurpassed polish retention for superb esthetics. ■

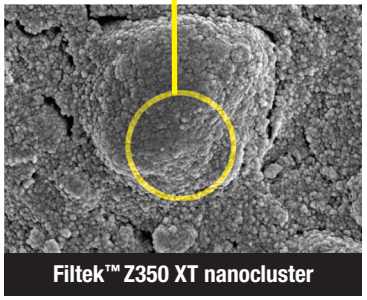


Typical hybrid composite

Figure 1



100K magnification of nanocluster



Filtek™ Z350 XT nanocluster

Figure 2

SEM photos are courtesy of Dr. J. Perdigao, University of Minnesota.

For complete information, download the Technical Product Profile for Filtek Z350 XT Universal Restorative at **www.3MESPE.com**.

100% nanofiller technology results in a nanocomposite with …

higher wear resistance

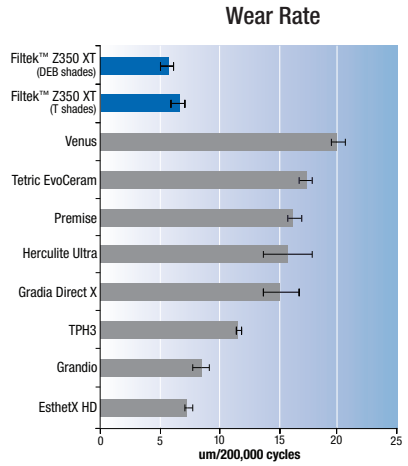


Figure 3: In vitro wear data.*

lasting polish retention

Typical hybrid composite | Filtek™ Z350 XT Universal Restorative Body shade | Filtek™ Z350 XT Universal Restorative Translucent shade

Figure 4: Side-by-side photos comparing composite surfaces after 6,000 cycles of toothbrush abrasion.

proven versatility

Photos courtesy of Dr. Grant Chyz, Seattle, WA.

Photos courtesy of Dr. Gabriel Krastl, Department of Periodontology, Endodontics and Cariology, University of Basel, Switzerland.