Nano-Composites and Composites in Physicians (Brief Review)

1Danial Nazeran, 2Maziar Nazeran and 3Zohreh Ebrahimi

1Young Researchers and Elite Club, Neyshabur Branch, Islamic Azad University, Neyshabur, Iran
2Sama Technical and Vocational Training College, Islamic Azad University, Neyshabur Branch, Neyshabur, IRAN
3Young Researchers and Elite Club, Neyshabur Branch, Islamic Azad University, Neyshabur, Iran

ABSTRACT

The acrylic matrix in a composite tends to shrink on setting. Excessive shrinkage in a filling material is undesirable because it would either leave a gap between the tooth surface and the filling material, or, if well bonded, would cause cracks in the tooth structure as the filling contracts during setting. Furthermore, any filling made from resin alone would wear very rapidly in service. These were the first type of resin composite marketed in the 1960’s for filling front teeth. As the name implies, the particles in a Nano-composites are fairly large. Crystalline quartz was ground into a fine powder containing particles 1 to 50 microns (µM) in diameter. The 1µM size is critical, since particles larger than this are visible to the naked eye. Particles 1µM and larger are called macro particles, while those smaller than 1µM are called micro particles.

INTRODUCTION

The inclusion of the glass particles reduces these problems because they reduce the volume of acrylic, and act as a mechanical “skeletal structure” within the composite to help maintain the original volume of the filling when it sets. The advantage of large particle size is that large numbers of particles can be incorporated into the paste without making it too stiff to manipulate. Nano-composites are 70% to 80% glass by weight, 60% to 65% by volume. (A micrometer, also called a micron, is a millionth of a meter, or a thousandth of a millimeter. An average grain of salt is about 60 microns.) Unfortunately, Nano-composites composites have two undesirable qualities. But wear is the major disadvantage of Nano-composited composites. The constant loss of the glass particles exposes more and more of the soft plastic matrix to the abrasive forces encountered in the mouth, and the restoration slowly wears away over time. However, the large particle size has one major advantage over small particle size. You can pack them more tightly into the resin matrix without the paste becoming too thick for the dentist to handle. This becomes more difficult to accomplish with small particle size. This is explained in detail below. More glass in the mixture reduces setting shrinkage. The relatively soft acrylic polymer tends to wear below the level of the glass particles, which constantly pop out of the surface leaving holes in their place. This leads to a surface which, on a microscopic level, looks like a series of craters interspersed with boulders. This type of surface is prone to staining. A composite restoration wears exclusively because the glass particles are slowly dislodged from the surface leaving more of the soft resin matrix exposed to wear factors. If there were a way to keep the particles in place forever, the restoration would never wear down. In theory, the less acrylic and the more glass a composite contains, the better. An ideal composite filling would contain only glass, and no acrylic at all. This, of course, is impossible, since the resin is the material used to glue the silica particles together. It is also the component that gives the polymerized material the handling characteristics that allow the dentist to work with it in the first place.

2. Methodology:

Any filling that wears excessively would allow the bite to change, and the teeth will move over time. Hybrids contain a range of particle sizes. First formulated in the 1980’s, they include about 75% conventional size particles (1-3 micron) and about 8% sub micron size (.02-.04micron) (Pictured to the right). They do not retain a high polish for long, due to the tendency of the largest particles to pop out of the surface, but they retain their easy working characteristics due to the high percentage of larger particle sizes. They are also much more

Corresponding Author: Danial Nazeran, Young Researchers and Elite Club, Neyshabur Branch, Islamic Azad University, Neyshabur, Iran
E-mail:d.nazeran@yahoo.com
resistant to wear than the older macros because of the smaller size of the particles overall, and because of the presence of the submicron particles, which are more difficult to dislodge than the larger particles. Also, they can be filled to a much higher density with glass particles than those composites containing only micro sized particles. The larger particles are necessary to keep the consistency of the paste from becoming too stiff, while the relatively small percentage of sub-micron size particles takes up the space between the larger particles. The highest particle density attained with hybrids is 90% by weight. Because of the high particle density, hybrids were the first composites that were promoted for posterior use, and they remain one of the most wear resistant posterior composite types on the market. A smaller particle has a relatively greater surface area in relationship to its volume than a larger one. A cube has a surface area equal to the sum of the area of its six sides. If the cube is cut in half, the two pieces together have a total surface area equal to the original cube plus the area of the two new sides created when the original cube was cut. As you continue to cut it up into smaller and smaller pieces, you continually add new surfaces to the original area of the cube. While the volume of the material you end up with is the same as the volume of the original cube, the surface area keeps expanding with each new segment created.

3. Results:
This fact gives micro particle sizes a major disadvantage when compared to macro sized particles. Since friction is a function of involved surface area, the increased surface area of micro particles also increases internal friction and a large volume of them included in the paste makes the composite so stiff that it becomes very difficult for the dentist to manipulate. According to Phillips Science of Dental Materials, “Colloidal silica particles, because of their extremely small size, have extremely large surface areas ranging from 50 to 400 square meters per gram.” Nano-composited composites are much easier for the dentist to handle than micros filled to the same density. On the other hand, greater surface to volume ratio gives micro particles one major advantage over macro particles. The greater surface area, combined with the smaller volume of micro sized particles, makes them more difficult to dislodge from the plastic matrix. Furthermore, when a micro sized particle does pop out, it leaves a smaller crater behind, and affects the surface characteristics of the restoration less than the larger crater that a macro sized particle would leave behind. In other words, the more micronized particles the composite contains, the more resistant the finished composite is to wear in the mouth. These dueling facts bring us back to square one. Macro composites can be filled to a very high degree without becoming too stiff for the dentist to work with, have minimal shrinkage, have good mechanical properties and are fine for anterior teeth, but they do not wear or polish well. Certainly, they are unsuitable for posterior applications where wear is a factor. On the other hand, highly filled micro filled composites would not only look great and resist shrinkage, but they would wear very well in any area of the mouth because of the better retention of their particles. Unfortunately, any composite that contains a very high percentage of disbursed micro and Nano sized quartz particles would be so stiff that it would be impossible for the dentist to handle. First formulated in the late 1970’s, microfilmed composites were (and still are) filled to a maximum of 38% by weight, 25% by volume. Even though the particles are tiny, and thus retain better in the plastic matrix, the low density of glass particles in the micros gives them poor mechanical properties, including poor flexural, yield and tensile strength. This changes the flow characteristics of the paste making it more difficult to work with than Nano-composited or micro hybrid composites. The major problem with microfilmed composites is that they tend to be sticky, and to slump while the dentist places them. Their main advantage is their superior ability to resist wear during service and to polish to a high shine. While the viscosity of these Nano composites can be adjusted by varying the size and density of the agglomerated Nano clusters, this does little to remove the sticky consistency, and only slows down the slumping.

4. Conclusion:
Micro filled composites also tend to be more opaque than the other forms of resin-glass composites. This fact, along with the poorer handling characteristics makes them less attractive for anterior buildups in spite of their inherent strength. The quintessential agglomerated micro filled composite is the original form of Heliomolar. While plain agglomerated Nano-fills are sticky and tend to slump, Nano-hybrids use the smaller, intervening particles to "take up the slack" between the larger particles and give the paste handling and esthetic characteristics that make them quite acceptable for anterior, as well as for posterior restorations. These composites have the wear characteristics of the tiny size of the particles in the agglomerated Nano clusters, as well as working characteristics and esthetics similar to the micro hybrids. R.Hamzaoui of University de Technologie de Belfort-Montbéliard, France, has studied the structure and magnetic properties of nanocrystalline mechanically alloyed Fe-10 wt % Ni and Fe-20 wt. %Ni alloys of mixtures. The average particle size of Fe was 7μm and Ni was 250μm; the ball to powder ratio 10:1, and rotational speed was kept constant at 400rpm. They have reported that the crystallite size decreases from 54±1.5 to 10.4±1.5nm and the internal strain ε increases from 0.10 ± 0.05 to 0.69 ± 0.05. The crystalline size and lattice strain with respect to Fe-20 Ni is D= 51.2±1.5 to 9.8± 1.5 nm for 96hrs of milling and lattice strain ε = 0.11± 0.05% to 0.72 ±0.05 %. The conclusion
of this work is Fe and Ni powders form solid solution accompanied by grain refinement and grins size reduced resulted in an increase of the magnetization and a decrease of the coercivity values as shown in the graph.

REFERENCES