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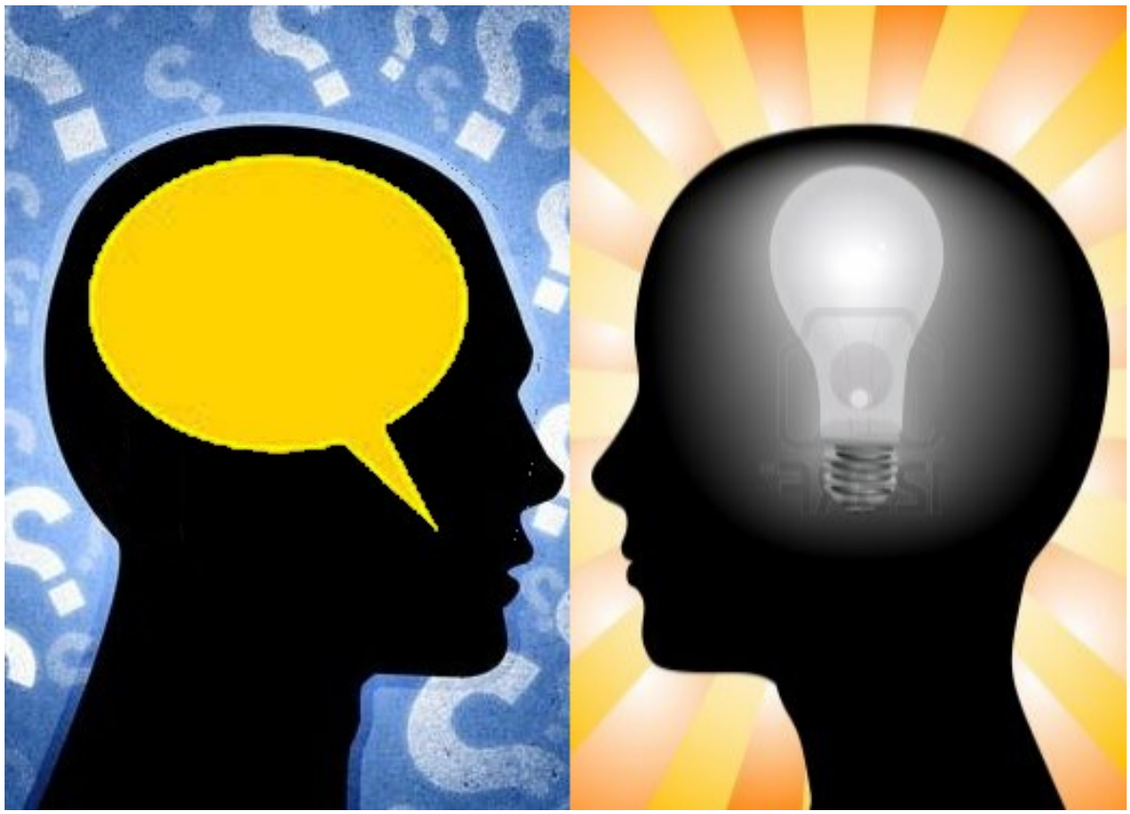

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Composites - The Recipe for the Menu

Dental caries, the bane of mankind, the cause of pain and agony for millions and the most prevalent form of dental disease. A problem that in generic terms is resolved by removal of all afflicted tooth substance and then restoring the lost structure with some form of suitable material as akin as possible to the natural tooth substance, dentin and enamel. A progression from Gold foil, amalgam, a mix of amalgam and resin and glass based ionomers have led to the composite restorative material.

Composite restorative materials comprise of a filler, a resin matrix and a catalyst which would initiate a polymerization reaction within the soft pliable plastic material in its native form after manufacture. If one ever tries putting together a self made composite restorative material one would have to first procure some unfilled resin.

Fig 1: A Class III cavity seen on the lower right incisor

Unfilled resin has the look, feel and consistency of a jar of honey. Technically the resin is formulated from a methacrylate base. The earliest and original form of this resin was BIS-GMA. Clinicians desires, marketing pressure and innovation saw the progression of BISGMA to UDMA to TEGDMA to PCDMA and now some new molecules after a seemingly brief stint with POLYSILOXANES. All these resins matrices have the ability to be polymerized or form complex chains of bonded molecules. This polymerization reaction is what converts it from the soft pliable state into a tough hardened permanent form.

Fig 2: Rectraction cord being placed to achieve isolation.

Fig 3: Etch being applied to the lesion prior to initiating bonding.

Interestingly these resins vary tremendously in their physical properties in their native state in terms of viscosity, color and texture and these make a significant impact of the final produced composite. Resins used in composite will always shrink i.e. reduce in overall volumetric dimensions when they polymerize. This shrinkage is a major issue for the restorative material and has to be minimized as much possible due to its direct clinical implication. Modifications of the filler particles is one approach.

A relatively newer foray has been to move away from the methacrylates and use a different chemistry created with siloxane and oxirane. The entire matrix base of the composite developed, comprises of this material.

Hence, there are no methacrylates in this composition. The fundamental basis of the oxirane rings opening and creating an expansion of volume, is a phenomenal concept which results in the reduction of the overall polymerization shrinkage.

The next ingredient is the filler. All fillers will have the look and feel of a powder. Depending upon the filler size, the powder would feel a bit grainy or

completely smooth reminding one of either the boric powder used on carom boards or the talcum powder used to beat the summer heat. It is a novel experience to take a pinch of this filler material and roll it between the thumb and the forefinger. A little bit of experience and one would be able to place the fillers in various groups on the basis of this simple test. The nano particle filler, which are the smallest particles used in dental composites, are the latest advancement seems to be all pervading.

Fig 4: Bond being applied on the lesion to enable the composite to be affixed

Fig 5: The bonding material has been light polymerized. The composite will now be applied.

These particles allow the composites to have properties very favorable and superior in various ways to the conventional filler particles. The fillers are generally grouped as macro fillers,micro fillers and micro-hybrid fillers with the nano filler as the newest entrant in the field. All particles in the 1000 micron plus range are classed as macro fillers and broadly these filler particle give high strength but very poor polishability and are today more or less out

of the scene. The micro fillers afford far more smoother finishes but then lose out on the strength. The micro filled composites are known to maintains the polish for a long-term, clinically are easier to marginate and known to be more stain & plaque resistant as well as more biologically compatible. The tend to have a very optimal wear-resistance and an excellent refractive & reflective index. The end result with a micro filled composite usually gives a more realistic translucency.

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The micro-hybrid filler based composites are stronger while still maintaining its high polishability and surface finish. Since the filler particles are a mix of large and micro size particles the materials always tends to be more opaque and even though the initial polishability is good, it does not maintain a long-term polish. It is also less wear-resistant and more difficult to marginate. In fact it can be said that the micro filled composites simulate enamel while the micro hybrid simulates dentine.

The nanoparticle seems to be the best of both worlds and is comprised of slightly large particles surrounded by much smaller particles.

Fig 6: Composite material being placed to fill lesion with a plastic instrument

Fig 7: The layered technique being used to restore the cavity


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Restorite
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Contents : 4g Syringe
Restorite Nano Hybrid
Light Cure Resin-Based Dental Restorative Material
Available Shade
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A2
A3
B2
Restorite
Nano Hybrid
PRIME
Available Packing : 4g Syringe
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Nano filled composites have very high polishability while retaining the high strength required for restorations. In fact the advent of nano technology has given a sudden boost to the material properties of composite materials. Used in varying forms the nano particle sized filler can be used as one of the components of the fillers alongside other sized fillers or as pure nano fillers in the form of nano clusters and nano particles. The structure of the teeth comprises of dentinal tubules, enamel rods and hydroxyapatite crystals in the nano particle size range. Nanotechnology helps improve the continuity between the tooth structure and the nanosized filler particle and provides a more stable and natural interface between the mineralized hard tissues of the tooth and these advanced restorative biomaterials.

Most filler particles are coated with a coupling agent to enhance the adhesion of the resin to the filler and thereby improve all material characteristics. The industry standard coupling agent that has been used has been silanes. These have been used for half a decade and still continue t be the best coupling agent.

Fig 8: The retraction cord being removed prior to polishing the new restoration

Fig 9: Polishing of the restoration being done with a series of tips

The flowability vs viscosity of the composite material is directly related to the percentage of filler content in the composite.As these ratios alter, characteristics of the composite material changes. Companies tend to tweak and modulate the properties by playing with these ratios and proportions.

The next ingredient in our recipe is the catalyst or the initiator that will trigger the polymerization reaction. This has to be added in a very small quantity and it does the job of exactly what its name states. It is the catalyst triggering of the ultimate desired reaction on a dental restorative material. These are generally triggered on exposure to a certain wavelength of light or by the mixture of two or more chemicals which initates the same kind of reactions and starts off a polymerization reaction. Unfortunately, all initiators also have some kind of other reactions and the most adverse one is its effect on color stability. The most commonly used photoinitiator is camphorquinone which matches the light spectrum of halogen as well as LED lights. This makes it the most widespread used photointiator. Camphorquinone has also been found to be more effective when combined with amines like DMAEMA, EDMA,TMA etc. of which, EDMA is the most commonly used reducing agent. The addition of iodonium salts and other free electron donors to this catalyst has been found to reduce the polymerization stress considerably and hence has a direct clinical benefit. The concentration of CQ used varies between 0.17 to 1.03 %. Hybrid and micro hybrids need concentrations more than the pure micro filled or nano filled composites. One of the alternative photo initiators that has been tried effectively is Diphenyl Phosphine Oxide (DPO). DPO has been found to generate a faster and greater percentage of polymerization than CQ + amines and the color stability also is more improved. The negative effects of CQ can be reduced by decreasing the concentration of the CQ +amine, but if the concentrations are too low the polymerization conversion ratio also falls down significantly.

Fig 10: The completed restoration

Fig 11: Another view of the completed restoration

TColors and tints are the last bit of this dish that has been cooked up. Composite materials are usually available in a wide range of colors and the Vita shade system has been followed even in composite materials. Colors are added to this cook book recipe to obtain varying shades of composites. It is not just the shade that is critical but also the opacity/translucency. This opacity or conversely the translucency of the material is what makes the same shade of composite from different companies look very different. It is very important to have the proper ratio and proportion of the hue to achieve the ideal end resultant. This ratio and concentration has to be adjusted on the basis of the filler particle size, the percentage of fillers as well as the kind of resin used. Obtaining the ultimate color match is an individual skill which has to be developed by the clinician with a mix and match of varying translucencies and shades.

The future holds excellent prospects for this recipe and constant improvements in material technology impacts and enhances the composite menu very favourably.

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