Colour Stability of Composite- A Review

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ABSTRACT

BACKGROUND
Current innovations in restorative dentistry include nanofilled composite resin materials for direct and indirect restorations. Moreover, the advances in adhesive dentistry have provided autopolymerising, dual-polymerizing and light polymerizing resin-based adhesives for ceramic restoration bonding. In addition, resin cements have been combined with self-adhesive components for adhesive procedures. Composite failure has been a great challenge for dental clinician all over the world, making it difficult for the dentist to satisfy patients. Major problems seen include polymerization, shrinkage and colour instability. There being no perfect method for this restorative material to overcome the problems, clinicians must keep in mind as to what material and technique should be used in a patient depending upon the case. The success of composite restorations is due to their colour stability over time. Accurate shade matching of tooth coloured restoration with the adjacent dentition is essential not only at the time of fabrication but also for the lifetime durability. Discolouration of composite resins can be caused by internal or external factors. Internally induced discoulouration is permanent and is related to polymer quality, filler type, and amount, as well as the synergist added to the photo initiator system. Alteration of matrix or filler components of resin composites and incomplete polymerization constitute intrinsic factors leading to discoulouration. It is reported that saliva, food components, and beverages may affect the aesthetics and integrity of dental composites. This is a factual truth for dental porcelain but in contradiction, colour instability in porcelain restoration is a common dilemma nowadays, especially when they are exposed to routinely consumable beverages. We have reviewed different factors responsible for colour stability of composite restoration, and different steps that can be taken to avoid discoulouration and polymerization shrinkage.

KEY WORDS
Composite, Polymerization, Colour Stability

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Restoration is one of the vital specialties of dentistry. In spite of improvements in materials used for restorative dentistry, there is no material that is ideal for this dental application. In the current periods, tolerable hue match for “posterior restorations” is also an imperative thought in aesthetic dentistry. Surface irregularity, surface lustre, and colour are the most important aesthetic essentials of a restoration. It is testified that saliva, food constituents, and beverages may affect the aesthetics and reliability of dental composites leading to its dilapidation in the oral environment. Change in colour of resin-composite is due to the external factors or inner factors. Within prompted stains are everlasting which are in association with polymer excellence, fillers type, amount, plus also the auxiliary synergist to the ‘photoinitator method’. In light-activated resin-composite, when curing is inadequate, yellowish change in is seen because of remaining unconverted camphor quinone. Moreover, additional constituent of the light activated system that is ‘tertiary aromatic’ or ‘aliphatic amines’ have a tendency to make yellowish or brownish stain with stimulus of ‘light’ or ‘heat’. The resin’s empathy for external stains is controlled with adaptation percentage and physical-chemical physiognomies, and aquatic absorption rate being of specific importance. Inside mouth cavity, for the reason that of apparent deprivation or a slim diffusion and adsorption of staining agents at the shallow layer of the resin-composite, the superficial or sub-surface staining of resin-composite is seen. Furthermore, outwardly brought stains is associated to surface coarseness, surface veracity, plus with refining system.

Conferring to “Asmussem E” and “Dietzch D et al.” at hand are 3 different sorts of resin-composite discolourations: 1) External dis-colouration: This is due to the growth of ‘plaque and external pigments; 2) Internal dis-colouration: This is due to the maturing of material; 3) Modification of the superficial colour because of apparent deprivation or slight infiltration with reaction of the tinting materials on the inner side of apparent resin-composite film. Colour stability can be defined as the capability of the restoration to hold the original colour. Oral cavity is having an active environment. There is existence of microbes, saliva and numerous ingestions of coloured food products which might affect the colour stability of the restoration. Moreover, physical and mechanical properties are given more attention than the property of colour solidarity of resin-composites which will hamper colour of the resin. Colour perception vary with person to person being a psychological issue and it can be portrayed differently by different person. So, to avoid this problem, colour assessing equipment made engaged and the records were collected in “CIE L*a*b* system”.

“CIE L*a*b* system” practices 3-D ‘colourimetric’ measurement; ‘L*’ values accord with intensity of the colour, ‘a*’ values to the red and green content, and ‘b*’ values to yellow-blue content”. The colour variations (∆E) is calibrated with the L*, a*, and b* values for each specimen, conferring to the subsequent formulation, it will controls the 3-D colour space: \[ \Delta E^a = \sqrt{(\Delta L^a)^2 + (\Delta a^a)^2 + (\Delta b^a)^2}/2 \], while brilliance values (DL*) were reached using \[ \Delta L^* = L^* (tx) - L^* (t0) \], in which ‘(tx)’ will represent dipping time and ‘(t0)’ the baseline. An observable colour difference which is ∆E* > 1.0 will be denoted to as tolerable up to the value ∆E* = 3.7, in individual visual grits made in vitro under ideal light situations. In this review there is detailed information of different factors influencing the colour steadiness of the resin-composite filling.

Factors Responsible for Colour Stability of Composite Restoration

Various factors are associated which affects the colour constancy of the “resin-composite”. Colour stability is association with the resin-matrix, dimension of its filler particles, “polymerization” degree and the colouring agents. Change in colour of teeth-coloured, resin might be due to interior or exterior elements. Intrinsic aspect includes physicochemical staining responses in the resin-composite matrix, in superficial and deeper layers of the resin composition, activated by ultraviolet (UV) irradiation, thermal energy, or humidity. Chemical change in colour of resin material has been ascribed to variation or oxidation in the amine-accelerator, oxidation in the configuration of the polymer matrix, and oxidation of the un-reacted pendant “meth-acrylate groups”.

INTRINSIC FACTORS

Matrix

According to studies urethane di-methacrylate was more colour stable than di-methacrylate matrix. Urethane di-methacrylate had lower water absorption and was found low viscous as compared to di-methacrylate only.

Fillers

“Ormocer” along its rigid matrix containing three-D linked “organic & in-organic ormoncer” had more wear resistance as well as can resist discolouration as compared to microfilled or micro hybrid composite. Excessive water absorption leads to expansion and also causes plasticizing of the resin-matrix component, hydrolysing the saline and leading to micro-crack development leading to discolouration.

Photo Initiators

Discolouration can be attributed to the efficacy of polymerization, more the degree of conversion, lesser the availability of residual monomer to get discolourled. According to studies LED unit caused least colour change when was compared with quartz – tungsten- halogen units and jet lite. When compared led with halogen lamp they used higher power density LED UNIT (790 mW/cm²) which according to Bala et al. high degree of monomer conversion.

EXTRINSIC FACTORS

Types of Food Colourant

Numerous types of food with colour agents have impending effect on the change in colour of the resin material which
include coffee and tea, aerated and non-aerated beverages and disinfection agents used in mouth washes have tendency to discolor.(17,18) Chlorhexidine a most commonly used broad - spectrum topical antibacterial agent for treatment of diseases which occur in oral cavity. It is seen that it causes discolouration of the restoration particularly with combination of the dietary intake. Intake of beverages including coffee or tea may lead to change in aesthetic and physical assets of the "resin-composite", thereby degrading its value of the composite. Sparkling drinks are acidic and can be disadvantageous to the assets of filling "resin-composite".\(^{(19,20)}\)

### Table 1. Common Extrinsic and Intrinsic Causes of Tooth Discolouration

| Extrinsic | Intrinsic |
|-----------|-----------|
| Food and drinks (beverages) | Pulpal necrosis |
| Tobacco use (all forms of tobacco) | Obliterating of chamber |
| Poor oral condition (stains and calculus) | Dental materials (ex. "Extensive amalgam restorations") |
| Topical medications (CHX) | Metabolic disorders (ex. "Alkaptonuria") |
| Metallic compounds Deposition of Fe, Mn, Hg | Enamel wear-off ("Abraction, attrition, erosion") |
| Enamel wear-off ("Abraction, attrition, erosion") | Antibiotic drugs (ex., "Tetracycline") |
| Dental materials (ex. "Excessive fluoride uptake") | Dental Fluorosis (ex. Excessive fluoride uptake) |

### STEPS TO AVOID DISCOLOURATION

#### Technique of Placement of Composite Restoration

Composite-resin helps for nominally aggressive or to make cavity when supposing the renewal of cavitated or missing tissues that allows for new notion known as "Bio aesthetics". It is normally quite well known that every resin-composites contract while polymerization guiding to disappointment. This contraction leads to many encounters while placing and photo-curing the composite.\(^{(21-26)}\)

Three important factors correspond to minimize "shrinkage" pressure: usage of a less material, a minor cavity structure aspect, and less communication with the contra-lateral cavity walls while "polymerization". The notably, known “incremental technique” declines shrinkage stress because of diminished polymerization resin amount. Every part is recompensed by the other, with the significance of polymerization contraction is least detrimental as only the amount reduction of the ending deposit might harm the bonded surfaces.\(^{(27)}\)

#### INCREMENTAL TECHNIQUES FOR DIRECT COMPOSITE RESTORATION

While placement of resin-composites in molar and premolar, using minute ‘increments’ is suggested by a lot of authors for placement and polymerization so that contraction stress can be lowered. Seeing anterior resin-composite filling, however the assignment of augmentations leads to reduced polymerization contraction tension, faults in layering systems will lead to outcome in filling which are too “translucent or opaque”. So as-to safeguard aesthetically courteous consequences, layering ideas notion be simple, methodized, and replicable.

### Horizontal Layering Technique

This horizontal engagement method employs “resin-composite” increment, all less than 2.0 mm dense [Fig 1]. The method stated to have increased the C-factor, and there-upon intensifications of the shrinkage stress in between the contralateral cavity walls is noticed.\(^{(28,29,30)}\)

### Oblique Layering Technique

The oblique method is achieved by putting a chain of “wedge-shaped” “resin-composite” augmentations. Every layer is light activated twice, majorly via the cavity walls and later commencing the occlusal surface, directing the trajectories of polymerization headed to the bonding surface [Figure II]. This method diminishes the “C-factor” and averts the alteration of cavity walls.\(^{(27-30)}\)

### Vertical Layering Technique

Put less parts of resin composite in ‘vertical’ manner beginning from 1st wall, which can be either, ‘buccal’ or ‘lingual’ and then taken to other side. Begin light curing from back of the wall, that is, if ‘buccal’ part is put on the “lingual wall”, it is photo activated from external surface of the “lingual wall”. This led to reduction in slit at ‘gingival wall’ which is made because of "polymerization contraction", hence forward leading to “post-operative sensitivity” and “secondary caries” [Figure III].
Stratified Layering Technique
This system was conceived and adapted to the growth of purposeful and anatomical restoration putting on the "esthetic" resin filling resources which comprise colours of dentin and enamel and including different translucent and intense colours.[31,32,33] It is a method made to carve several grades of chroma existing inside a tooth. Which include putting dentinal “shades” of resin-filling with a advanced “chroma” in the middle of the prepared cavity and putting a "lower chroma" resin near to the cuspal walls. The "stratified layering" method is achieved by putting dentinal coatings of resin-composite “shades” or “chromas” that are of 2 or 3 degree advanced than the elected normal shades or “chroma”. Precise differences in dentinal colour can be attained by altering the width of each “chroma layer” in exact areas of the restorations. The “enamel layer” is positioned succeeding the outlines entrenched by the dentinal layers and contrasts in width reliant on the acceptable consequence. The "enamel layer" can be altered by putting different “shades” of “opalescent” or “intensive enamels” on different places of the fillings. [31,32]

Centripetal Build-Up Technique
This method provides a lot of upper hand when paced posteriorly. This method engages fine’ metal matrix band’s and wooden wedges [Figure IV] moreover, current readings doesn’t designate any impairment of “metal matrix bands” in cervical breach development.[34]

Added importance for this method is appointed by the “centripetal build-up steps” 1st by making an exact slim “proximal layer” [Figure 4]; the interior “curing” of this layer is contrived which can reinforce the “resin-composite” and reduce cervical space.[35,36] Moreover, there is space seen, very following layer filling the ‘gingival floor’ will fill the gap. Construction of ‘occlusal surface ring’ is an alternative important accumulation of the given method. By putting unceasing increment to “cusp slopes”, an “occlusal” orientation base is designed, evading over-filling and decreasing the very necessity for ‘rotary burs’. This finishing-polishing procedure are seem to harmful for exterior surface of the composite-resin.[37] ‘Centripetal build-up technique’ being conventional with safeguarding of good teeth structure, is time-consuming and it is easy to execute.

Split-Increment Horizontal Layering Technique
When ‘horizontal technique’ is put to use, all the resin-composite increase which contact cavity walls leads to maximum C factor [28,29,30] THERE has been concern relating to put ‘increments’ against the opposite walls at the same time, this will lead to shrinkage stress which will bend the
cusp onward each other giving deformed result. It might lead to post-operative ‘sensitivity’ and might be damaging for the teeth along with ‘marginal integrity’. [38] for the given method, every ‘horizontal increment’ was fragmented, beforehand polymerizing, into “four triangle-shaped portions” [Figure 7], with every serving sited alongside individual ‘cavity wall’ and single ‘diagonal cut’ was occupied entirely with “dentine shade” composite-resin and light-cured. At this very point, another “diagonal cut” was packed and light -cured, one part a time. Similar system is used till “dentine & enamel” junction and after ‘enamel shade composite’ trailed by ‘translucent shade’ are put and formed to start ‘occlusal morphology’. This will uniformly decrease the “C-factor” ratio from five, which is the maximum and the greatly disapproving, to the subsequent most promising “C-factor ratio” of 0.5.

Successive Cusp Build-Up Technique
Here, separate “cusps” filled one by one up to the equal of the “occlusal enamel” ! Small slanted additions are smeared to each curve of the prepared cavity [Figure VI] in-turn and handling is set aside to a lowest, to dodge foldaway spaces into the material. This process at first is time wasting, and might critically decrease ‘finishing’ time by exact consideration to progressive re-construction of usual morphology. [39]

Separate Dentine and Enamel Build-Up Using an Index
Using this disparity will re-establish decayed teeth with unbroken occlusal surface. After “rubber-dam” engagement, a pre-operative “impression” is to be taken of the occlusal-surface. When layered “dentine” filling is done, the impression material is used to help exact alteration of the concluding “enamel” increments. By cautiously controlling of the quantity of composite used, this system may totally reject the concluding phase [Figure VII]. [39]
Three-Site Technique
This system which is related to the usage of a pure “matrix” and brooding wedges. Firstly, the “light-curing” is fixed through the ‘matrix and wedges’ in the effort to guide the “polymerization” trajectories on the way to the gingival boundary hence stopping any space development. Then, “wedge shaped” “resin- composite” additions are positioned to further impede alteration of cavity walls and decrease the “C factor” [Figure VIII]. This system is related with “polymerization” first through the cavity walls and then from the occlusal surface in command to unswerving the trajectories of “polymerization” in the direction of the adhesive surface.[28]

Bulk Technique
This system is suggested by some writers to decrease pressure at the ‘cavosurface margins’.[47] While “anterior composite” filling are omnipresent, using innovative several layering systems by means of selection of “shades”, opacities, and translucencies rests the domain of fairly few dental-practitioner. This succeeding simple dual shade and more complex multi-layered engagement sequences are obtainable as systematic guidelines for all practitioners yearning to form added natural seeing direct anterior “resin-composite” filling.

Dual-Shade Layering Technique
Rudimentary dentist is suggested to create self-assurance in layering systems by commencement with binary material “shades” as this easy system is stated to convey a tolerable colour competition in a big number of scientific situations. Subsequent “etching and adhesive submission”, ‘opaque dentine’ material is functional, formed, and light cured. Most dentine filling materials are in the shade group-A and assortment of the corrected chroma is a crucial to triumph. “Palatal, proximal, and labial enamel” augmentations are then layered, free hand over the opacious dominant core at roughly fifty percent width of remaining enamel.[40]

Polychromatic Layering Technique
Whenever aesthetic loads are great, the extensively acknowledged stratification system projected by “Lorenzo Vanini” is suggested.[41] The essential code of ‘polychromatic’ layering system is to use diverse “resin-composite” shades to duplicate the coatings seen in usual teeth which can be labelled in coats as ‘palatal enamel layer’, ‘dentine layer’, distinctive types, opalescent, classifications, and intensives[42]

CONCLUSIONS
Direct resin-composite fillings have become an essential portion of today’s dental practice. With growing technical progression, there has been up-gradation in resin-composites, which will advance efficacy and speediness of their assignment, with the intension of extended-lasting and correctly shaped filling. A careful functioning system alongside suitable case assortment oversees the accomplishment of resin-composite filling.

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