

657 Effect of Antimicrobial Ingredient on the Color Stability of Composite. T.K. VAIDYANATHAN, J. VAIDYANATHAN, R. MEHRA*, RE. MONTGOMERY and S.A. NATHOO (NJ Dental School, Newark, NJ and Ora-Central LLC, Monterey, MA)

The objective of this investigation was to determine whether the incorporation of a broad spectrum experimental antimicrobial agent in a dental composite resin alters the color stability of the composite. The antimicrobial agent Halo™ (Halo Scientific, Monterey, MA) was incorporated into a composite by mixing in a light controlled chamber at final concentrations of 0, 0.25, 0.5 and 1% (w/w). After two weeks of equilibration, 3mm thick x 15mm dia disc specimens (N=5) were prepared for the commercial control A, processed control B (control A mixed and equilibrated without Halo™) and the experimental systems with Halo™, and the specimens were light cured for 30 sec. The discs were then stored in a humidity chamber for 48 hrs. to continue the post-cure conversion process and simulate the *in vivo* conditions. Pre-UV exposure color values (lightness L* and chromaticity coordinates a* and b*) were first determined using a Minolta Chroma mater CR 221. Color measurements were carried out at six random locations on each disc. The discs were then placed on rotating table (33 rpm) in a color stability chamber and exposed to UV light for 24 hrs. using a sun lamp as per ADA spec # 27. The post-UV exposure color values were also measured as described previously. The color change (ΔE^*) values were determined by the CIE L*a*b* color change equation. The mean and (SD) values of ΔE^* are as follows: Control A: 1.73 (0.97); Control B: 1.24 (0.87); 0.25% antimicrobial: 1.75 (0.71); 0.5% antimicrobial: 1.25 (0.44) and 1% antimicrobial: 0.82 (0.5). Statistical analysis showed no significant differences ($p > 0.05$) between the control and experimental groups. It is concluded that incorporation of an antimicrobial agent to a composite resin has no adverse effect on its color stability.

1658 Color Stability of Restorative Materials After Accelerated Aging. R.M. FAY*, J. MANHART, D. LI, R. HICKEL, J.M. POWERS (UT-Houston Dental Branch, Houston, TX, University of Munich, Munich, Germany).

Long-term color stability is important for a successful esthetic restoration. Color stability of 10 tooth-colored restorative materials was assessed when exposed to accelerated aging. Materials (shade A2) were composites: Arabesk (AR), Tetric Ceram (TC); compomers: Dyract AP (DAP), Dyract (DY), Luxal (LX), PrimaFlow (PF), Hytac (HY), Compoglass F (CF), F2000 (F); and ormocer: Definite (DF). Five specimens (10 mm diameter x 2 mm thick disks) were made. Disks were prepared in a PTFE mold on a flat glass surface with Mylar matrix and light cured for 40 seconds per side with an Optilux 400. The light was monitored with a light meter. After 24 h storage in an incubator, baseline color was measured. Specimens were then artificially aged in a weathering machine (Weather-Ometer C135) for a total irradiation of 450 kJ/m² at 340 nm. Color was measured using the CIE L*a*b* color system (illuminant A) against a white background on a reflection spectrophotometer (Color-Eye 7000) at baseline and at each of the different intervals. Color change (ΔE^*) was calculated as $\Delta E^* = (\Delta L^* + \Delta a^* + \Delta b^*)^{1/2}$. $\Delta E^* > 3.3$ was considered visually perceptible. Means and standard deviations of ΔE^* were calculated. Data were analyzed by ANOVA and means were compared by a multiple comparison test. At 450 kJ/m², statistically significant differences ($p < 0.05$) occurred between AR and all other materials except TC; between F and all other materials; and between PF and TC. Two materials exhibited perceptible color changes—AR ($\Delta E^* = 3.6$, SD=0.9) and F ($\Delta E^* = 11.9$, SD=1.1). All others exhibited ΔE^* values below 3.3. Supported in part by 3M Dental Products.

1659 Color Stability of Restorative Materials Exposed to Fluoride Varnishes. T. DEBNER*, D. WARREN, J.M. POWERS (Houston Biomaterials Research Center, UT-Houston Dental Branch, Houston, Texas, USA).

Color stability of a compomer (DY), hybrid ionomer (FLC) and composite (TPH) after staining with 3 fluoride varnishes was studied. Five disks (10-mm diameter, 2-mm thick) for each varnish were prepared in a mold and incubated at 100% RH at 37 C for 24 hours. Disks were then exposed to DuraFlor (DF), Duraphat (DP), FluorProtector (FP), and water (control) and then brushed 3 times. Both Mylar and polished surfaces were tested. Color was measured at baseline and after staining and brushing by CIE L*a*b* (source C) against a white background on a reflection spectrophotometer. Color change (ΔE^*) was calculated. Means (n=5), standard deviations and Tukey-Kramer intervals ($p=0.05$, TKI) of ΔE^* of polished surfaces after staining and brushing are listed. Repeated-measures ANOVA showed statistically significant differences.

Product	Stain	Water	DF	DP	FP	TKI
DY	Stained	1.5 (1.2)	15.9 (3.0)	18.6 (2.7)	0.9 (0.6)	1.2
	Brushed	1.3 (1.1)	1.6 (0.7)	1.7 (0.4)	1.0 (0.4)	
FLC	Stained	1.3 (0.8)	12.2 (2.5)	15.2 (4.7)	2.0 (0.8)	1.6
	Brushed	1.8 (1.1)	1.3 (0.6)	1.4 (0.5)	2.0 (0.4)	
TPH	Stained	0.5 (0.2)	10.5 (1.7)	18.7 (5.6)	1.3 (0.8)	1.6
	Brushed	1.0 (1.5)	5.4 (1.5)	1.5 (0.5)	0.9 (0.9)	

Varnishes DF and DP caused a perceptible color change ($\Delta E^* > 3.3$) in DY, FLC and TPH, but the stain disappeared after brushing, except for TPH/DF. FP did not affect the color of the composite, compomer or hybrid ionomer. Supported by a Dean's Fellowship.

1660 The Color of Dissimilar Layers of Esthetic Direct Restorative Materials. E.Y. KANG*, J.C. RAGAIN and W.M. JOHNSTON (The Ohio State University College of Dentistry, Columbus, OH, USA and Naval Dental Research Institute, Great Lakes, IL, USA)

Our purposes were to validate the application of Kubelka-Munk reflectance theory (K-M RT) to dissimilar layers of direct esthetic restorative materials, and to determine the color accuracy provided by this theory for these materials. For each of five brands of direct restorative materials (Herculite XRV, TPH, TPH Spectrum, Compoglass, & Dyract), three shades were selected to be the outer layer, and three other shades were selected as the underlying layer. Samples of the outer layers were reduced to uniform thickness of approximately 1mm. The optical absorption and scattering of these outer layer samples were determined using diffuse reflectance spectroscopy in the visible range (DRS-V). The visible reflectance spectra of samples of the underlying layers were also recorded. K-M RT was used to calculate the reflectance of each combination of the outer layer on each underlying layer of the same brand, and these combinations of dissimilar shades were measured using DRS-V. Color differences were determined between the colors obtained from the calculated and measured reflectance spectra. The correlation coefficients between the calculated and measured color parameters were 0.94 ($p < 0.001$) for L*, 0.98 ($p < 0.001$) for a*, and 0.97 ($p < 0.001$) for b*. The color difference between the calculated and measured colors averaged 1.1 CIELAB units. K-M RT is applicable to layers of dissimilar shades of esthetic direct restorative materials, and the color inaccuracy is well below the color difference which would be considered clinically unacceptable.

1661 Predicting Color Stability of Acrylic Resins Using Electron Spin Resonance. A. HASEGAWA*, T. HAMANO*, S. NAGASAKA* and M. MIWA* (GC Dental Products Corp., Kasugai, Japan; *Univ. of Gifu, Gifu, Japan).

Long periods of time can be required to determine the color stability of autopolymerizing acrylic resins which are composed mainly of methylmethacrylate (MMA). The aim of this study is to predict the color stability of the acrylic resins using electron spin resonance (ESR). Two kinds of initiator system were used in this study, these were the binary (BPO-tertAmine) and ternary (Barbituric acid derivatives) systems. The MMA propagating radicals of those materials were immediately observed at room temperature after starting the reaction. The radical concentration was estimated from the area under the integrated ESR spectrum. The color of each material was measured by means of a color computer in accordance with CIELAB color spaces. The radical concentrations for the binary system rose rapidly with advancing time until 60 minutes had elapsed. The higher the content of BPO, the more the radical concentrations were given. On the contrary, the radical concentration for the ternary system was only slightly up with advancing time, and significantly lower compared with those of the binary system. Using regression analysis two significant positive correlations were found between b* and the radical concentration ($r=0.954$, $p < 0.001$), and between ΔE^*_{ab} and the radical concentration ($r=0.847$, $p < 0.01$) respectively. However no correlation was found between a* and the radical concentration. It was found that the higher the radical concentrations, the higher the value of b* became for the acrylic resins. In conclusion it was suggested that the long term color stability of the acrylic resins was predictable by measuring the radical concentration using ESR immediately after the reaction was initiated.

1662 A New Screening Test for Toxicity Testing of Dental Materials. M. PELKA, CH. DANZL*, W. DISTLER, A. PETSCHTEL (Poliklinik für Op. Dent., Univ. of Erlangen-Nuremberg, GÜckstr. 11, D-91054 Erlangen, GER)

An *in vitro* test system is described which allows a quick and relatively inexpensive evaluation of the potential chemical toxicity of new dental filling materials used in the restoration of teeth. We developed a micro plate assay for cytotoxicity testing of dental materials based on a bioassay using green shrimps (*Artemia salina*) as sensitive organisms. The test-materials were polymerized and consecutively milled. After incubation of 1 g in 4 ml distilled water at 37° C for 48 h the solid materials were separated by centrifugation (15 min, 2500 U, 1250 Xg). The solution was equilibrated with NaCl to a salt content of 25 g/l. Aliquots of 200 µl were distributed in 8 micro wells and 5 µl of an *Artemia salina* containing (8-14 shrimps) salt solution were added to each well. After 24 h the shrimps were sacrificed using Na-acid (5%) and counted again. 255 µl salt solution was used as standard. With this methodology we tested the composites Arabesk® (VOCO, Ger.), Solitaire® (Kulzer, Ger.), Partac® II (ESPE, Ger.), Tetric® (Vivadent, Liechtenstein), Herculite® (Kerr, Ger.), and the compomer materials Dyract® (DeTrey, Ger.), Hytac® (ESPE, Germany) and Compoglass® (Vivadent, Liechtenstein). All compomers and Solitaire reached 100% lethality after 24 h and showed significantly ($p < 0.01$, signed rank test) higher toxicities than the remaining composites. With exception of Partac II all composites showed significantly higher toxic values than the standard. Partac II never showed any differences with the standard used. The new technique has some advantages over cell culture toxicity tests for restorative materials, because it can be carried out quickly with low costs. The disadvantage is the high quantity of material used and the low sensitiveness. Our new introduced test design should be suitable for a quick, inexpensive toxicity screening of dental materials.

1663 Discoloration of Facing and Filling Materials by UV Irradiation R. LANG*, M. ROSENTRITT, M. BEHR, and G. HANDEL (Department of Prosthetic Dentistry, University of Regensburg, Germany)

The discoloration of tooth-colored composite material, caused by UV irradiation or thermal energy, can be one reason for the replacement of dental restoration. The purpose of this study was to investigate the color stability of five facing and three filling materials under various levels of UV-irradiation. 16 cylindrical specimens (height 5 mm, diameter 6 mm) for each material listed in the table below, were fabricated according to the manufacturers instruction. After the baseline measurement of the CIE-L*a*b* color data with a reflection spectrophotometer (Minolta CM 3500d), artificial aging was carried out in the case of 8 samples by simulated exposure to natural daylight in a filtered xenon lamp (Xenotest, Heraeus Instruments) with an irradiation value of 765 W/m². Eight samples of each group were stored as a control series under light

Facing Materials	ΔE^* 24 h / 72 h
Conquest Sculpture	0.6 / 1.0
Thermospan LC	2.1 / 2.0
Vita Zeta LC	1.1 / 0.8
CompPlus	2.2 / 2.3
beke Glas HP	2.6 / 2.9
Filling Materials	ΔE^* 24 h / 72 h
Definite	1.7 / 2.2
Aniston ptc	2.3 / 2.0
Spectrum TPH	1.4 / 0.9

exclusion in de-ionised water. After 24 and 72 hours of irradiation a further color measurement was carried out and the color differences ΔE^* referring to the baseline measurement were calculated. The color values of the control group were measured again after 10 days' storage in de-ionised water. Statistical analysis was performed using the Mann-Whitney U-Test ($p \leq 0.05$). Medians of color differences ΔE^* after 24 and 72 hours UV-irradiation are listed. After 24 and 72 hours of aging (ISO 7491) all materials showed a clinically acceptable discoloration of $\Delta E^* < 3.3$.

1664 Extractable residual monomers/additives from resin-modified GIC and a polyacid-modified resin. B. SCHMIDT, P. BUBECK, C. THEILIG, M. SCHMIDT-ROSIECKA, V. NEITEMEIER, J. MUNACK*, G. LEYHAUSEN, W. GEURTSSEN, Dept. Organic Chem. & Dental Hospital, Hannover, Germany.

Previous studies indicate that polymerized resin-modified (rm) GICs and polyacid-modified (pm) resins ("compomers") may liberate considerable quantities of monomers and additives. It was the aim of this study to determine the nature of organic components in various aqueous extracts from those materials. Equally sized specimens (free surface: 70.7 mm²) of the rm GIC Vitremer™ and the pm resin Compoglass F™ were polymerized according to the manufacturers' instructions 24h after polymerization, each 3 specimens were extracted in 5mL acidic buffer (pH 4.2) or in 5mL neutral buffer (pH 7.0) for 24h and then for another 6d. All extracts were qualitatively investigated by GC/MS. Each assay was repeated at least twice to ensure reproducibility. In all extracts various organic components were identified. *rm GIC/pH 4.2*: 24h - BEMA, EGDMA, TEGDMA, HEMA, 6d - BEMA, DEHP, EGDMA, HEMA, MMA, TRIPP. *rm GIC/pH 7.0*: 24h - BHT, EGDMA, TEGDMA, TEEGDMA, HEMA, MMA, CEMA, EGDMA, DEHP, EGDMA, TEGDMA, HEMA, TRIPP. *pm resin/pH 7.0*: 24h - BHT, DEHP, EGDMA, DEGDMA, TEGDMA, TEEGDMA, TEGDMA, HEMA, 6d - BDDMA, BEMA, CEMA, EGDMA, DEGDMA, TEGDMA, HEMA, TRIPP; *pm resin/pH 4.2*: 24h - BHT, DEHP, EGDMA, DEGDMA, TEGDMA, TEEGDMA, TEGDMA, HEMA, 6d - BEMA, EGDMA, DEGDMA, TEGDMA. From our data we conclude that various organic substances may be segregated from the investigated materials in dependence upon the medium. Some of these components might cause side effects according to the RTECS/NIOSH. (Supported by grants of the DFG Ge 455/4-3 and 455/11-1).