

Futurabond U – Cusp deformation/marginal integrity

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When placing fillings in cavities using adhesive techniques, stresses occur within the cavity as a result of curing. So-called shrinkage stress, which affects the walls of the cavity, can be calculated using the shrinkage and the modulus of elasticity of the composite. Studies on cusp movement and marginal integrity have a clear clinical relevance; with the aid of the correct cavity preparation, they simulate the stress conditions which actually occur. In the study carried out by Fleming et al. which is summarised here, various universal bonding systems were tested in combination with the respective manufacturer's own composite. In the process, the effect of previous etching on the cusp movement of the tooth during polymerisation was tested in particular, followed by the marginal integrity.^[1]

In the course of the renewal of amalgam restorations, large MOD cavities are treated with composites. In the process, a cusp movement can occur due to the shrinkage of the composite. It is necessary to consider the cusp movement and the marginal integrity of the composite restorations in combination to enable a better understanding of *in vivo* processes. A low level of shrinkage in the composite during curing means a low degree of cusp movement in the tooth, and this can be shown on a micrometer scale with a cusp deformation measurement. However, a low degree of cusp movement can also be caused by a partial loss/loss of the retention of bonding agent/composite to the tooth. For this reason, it is useful to check the marginal integrity of the restoration after measuring the cusp deformation in order to enable the correct evaluation of all measured values.

Test set-up

At the University of Dublin, Fleming et al. examined cusp movement during the placement of restorations and the marginal integrity of the restorations in a total of 56 maxillary premolars. Three universal bonding systems were tested in both self-etch and total-etch mode, along with a purely self-etch bonding system. Thus, the test specimens were divided into 7 groups (A-G).

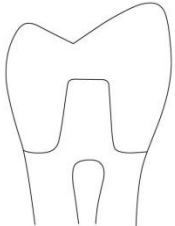
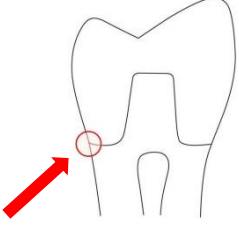
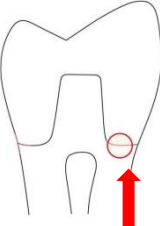
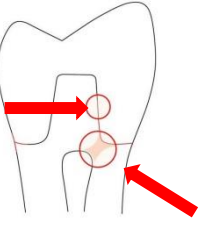
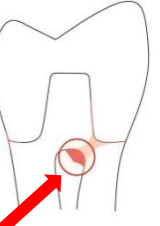
Table 1: Group distribution of the test set-up

Group	Composite	Adhesive	Etching mode
A	Filtek Supreme XTE	Scotchbond Universal (SB U)	Total-etch
B	Filtek Supreme XTE	Scotchbond Universal (SB U)	Self-etch
C	GrandioSO	Futurabond U (FB U)	Total-etch
D	Spectrum TPH3	Prime & Bond Elect+ (P&B E)	Total-etch
E	GrandioSO	Futurabond U (FB U)	Self-etch
F	Spectrum TPH3	Prime & Bond Elect+ (P&B E)	Self-etch
G	Filtek Supreme XTE	Adper Prompt L-Pop (Prompt)	Self-etch

With the aid of the adhesives, the respective manufacturer's own composites were layered in the MOD cavity using the incremental technique, polymerised, and the cusp movement during curing was then determined. Afterwards, the restorations were tested for their marginal integrity. To this end, the teeth were sealed. The teeth were sealed apically with wax. In addition

all tooth surfaces were coated with nail varnish except for a 1 mm-wide strip around the restoration margins. After thermocycling, the teeth were immersed in fuchsin for 24 hours (basic, 0.2%), cut into, examined under a microscope to determine the penetration depth of the colourant and then classified using the marginal integrity factors specified in Table 2.

Table 2: Explanation of the marginal integrity factors

0	1	2	3	4
No penetration by the colourant	Superficial penetration (not beyond the enamel-dentine junction)	Penetration along the gingival floor	Penetration as far as the axial wall right up to the pulp	Penetration of the pulp chamber
				

Examination of cusp movement/marginal integrity

Three universal bonding systems (Futurabond U, Scotchbond Universal, Prime & Bond Elect) and a purely self-etch bonding system were tested in combination with the composite from the corresponding company. GrandioSO was fixed in place adhesively using Futurabond U. For the cusp movement, no significant differences can be discerned between the etching modes (Self-etch mode: 9.98 μm , total-etch mode: 10.26 μm), which can be attributed to the universal use of the bonding system (see Fig. 1). The shrinkage of GrandioSO is 1.61% by volume[#]. Accordingly, only a very slight cusp deformation can be observed.

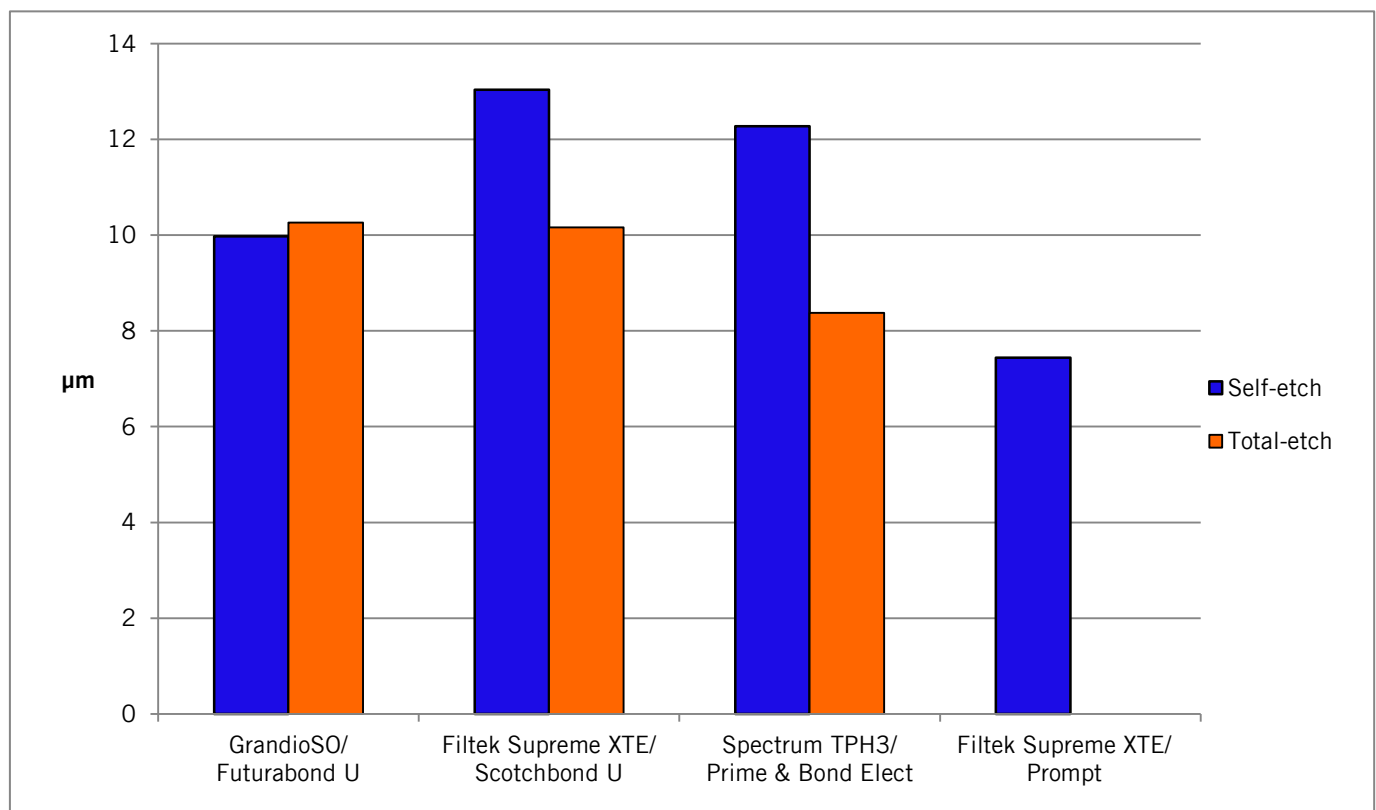


Fig. 1: Cusp movement, MOD-prepared teeth restored using bonding agent/composite

The differences between the etching modes, which can be observed with the other universal bonding systems (Scotchbond Universal, Prime & Bond Elect), can be explained by a partial loss/loss of the retention between the composite/bonding agent and dental hard tissue. In Fig. 2, this becomes clear upon consideration of the marginal integrity

factors. The distribution of marginal integrity factors is much wider with Filtek Supreme XTE/Scotchbond Universal and Spectrum TPH/Prime & Bond Elect in comparison to GrandioSO/Futurabond U. The values for the self-etching modes, where high factors occur far more frequently, are particularly striking. The cusp deformation for the test group Filtek Supreme XTE/Adper Prompt L-Pop is the least at 7.44 µm. But of all of the systems tested here, it is precisely test group G which exhibits the least marginal integrity. The low level of cusp movement is thus the result of a loss of retention between the composite, the bonding agent and the tooth. GrandioSO impresses not only with its low level of cusp deformation, which can be observed regardless of the etching mode, but also with the related narrow distribution of marginal integrity factors. Only values between 1 and 2 have been observed. The lower these values turn out, the lower the probability of marginal discolorations, marginal deficiencies and secondary caries.

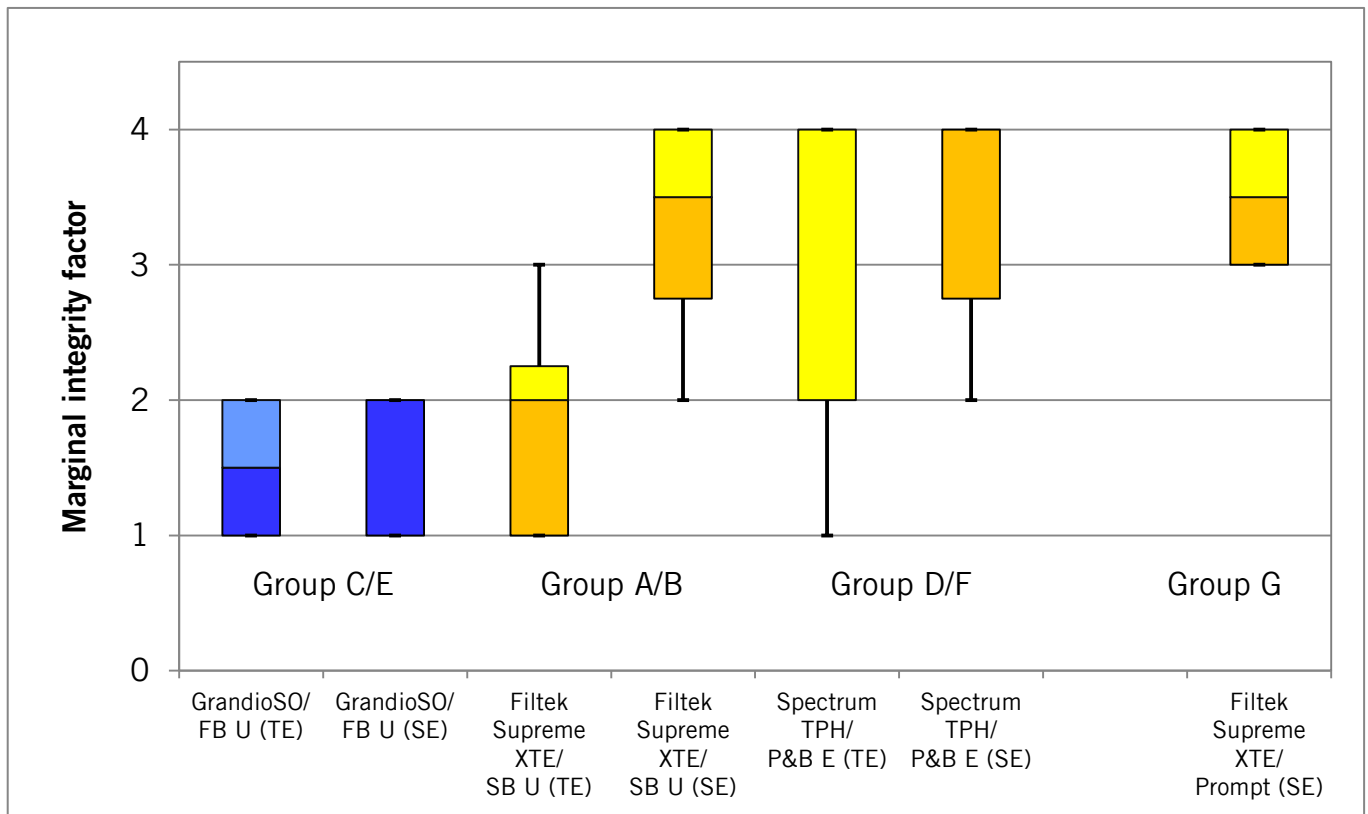


Fig. 2: Marginal integrity factors of various bonding systems with the respective manufacturer's own composite. The box plot illustrates the sum of the marginal integrity factors based on the median*, the quartiles** and the extreme values. The box shows the interquartile range***, which includes 50% of the marginal integrity factors. The antennae show the highest and lowest values which occurred during the measurements. The black line in the box shows the median marginal integrity factor.

Conclusion: The treatment of MOD cavities using Futurabond U/GrandioSO impresses right across the board. The cusp movement which occurs during curing is minimal and does not depend on the etching technique used. The subsequent marginal integrity measurements show very impressive values, which likewise do not differ significantly depending on the etching technique used. This measurement confirms once again that long-lasting, aesthetic restorations can be produced using the combination of Futurabond U and GrandioSO.

[1] G. J. P. Fleming, report to VOCO, June 2013

+ Prime&Bond Elect is not sold in Europe

Method according to Watts

*Median: Midpoint value for distributions in statistics (0.5 quantile)

**Quartiles: e.g. 25%, 50%, 75%

***Interquartile range: Difference between the upper quartile (75%) and the lower quartile (25%)