



## Introduction:

The group of all-in-one self-etching adhesives are in today's focus of interest in dental material science and gaining increasingly acceptance by the practitioners. All manufacturers claim high bonding efficiencies of their products. Usually, the bonding efficiency is given as shear bond strength (SBS) or micro tensile bond strength after 24 h water storage or after thermocycling for several days. However, only few is known concerning the the bonding efficiency within the first 24 h. The disadvantage of the bond strength test is that it has to be done by an experienced operator and is very time consuming. In contrast to that the determination of the degree of conversion (DC) by FTIR-spectroscopy is a fast method to evaluate the material properties of dental composite.

## Objective:

This study was conducted to determine the degree of conversion by FTIR-spectroscopy and the shear bond strength to human molar enamel of self-etching adhesives at different times after light activation.

## Materials:

*Absolute*, Lot: 388-007, Dentsply-Sankin; *G-Bond*, Lot: 0405111, GC-Corporation; *Hybrid-Bond*, Lot: KK2, J. Morita Europe; *iBond*, Lot: 010061, Heraeus Kulzer, *experimental iBond*, Lot: VP 070904AK3, Heraeus Kulzer; *Venus A2*, Lot: 010111, Heraeus Kulzer  
The adhesives were applied according to manufacturers instructions. Light activation of adhesives and composite (Venus, Heraeus Kulzer) was done with a standard halogen curing unit (Translux Energy, Heraeus Kulzer).

## Method:

DC was determined using FTIR-ATR spectroscopy (Spectrum One, Universal ATR Sample Accessory, Perkin-Elmer). FTIR-spectra were recorded immediately, 10 min, 1 h, 2 h, and 24 h after irradiation from five adhesive specimens covered with Venus, each. DC values were calculated from the ratio of absorbance intensities of aliphatic carbon double bonds (1638 cm<sup>-1</sup>) against internal standard (1534 cm<sup>-1</sup>) before and after polymerization.

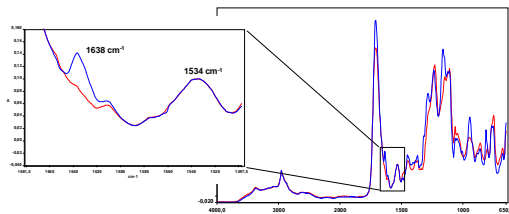


Figure 1: Example of FTIR spectra of iBond before (blue line) and after (red line) light activation. Small box: Magnification of relevant region.



Figure 2: FTIR-ATR spectroscopy, Spectrum One, Universal ATR Sample Accessory, Perkin-Elmer (left photograph) and prepared adhesive film on sample holder before measurement (right photograph).

For shear bond strength flat enamel surfaces (n = 8) were prepared on SiC paper grit 320. The composite was bulk filled in cylindrical Teflon molds (3.5 mm in diameter) and cured for 60 s. Shear bond strength was determined after 10 min and 24 h storage of specimens in 37 °C tap water (according to ISO TS 11405). Statistical analysis was done by ANOVA and Duncan (p<0.05).

## Results:

### 1. Degree of Conversion:

	Absolute	G-Bond	Hybrid Bond	iBond	exp. iBond
immediately	58,8 <sup>a/A</sup>	83,1 <sup>a/D</sup>	56,2 <sup>a/A</sup>	79,0 <sup>b/C</sup>	72,7 <sup>a/B</sup>
10 min	63,0 <sup>b/A</sup>	85,3 <sup>b/C</sup>	60,6 <sup>b/A</sup>	84,7 <sup>b/C</sup>	76,4 <sup>ab/B</sup>
1 h	65,7 <sup>bc/A</sup>	87,6 <sup>c/C</sup>	66,1 <sup>c/A</sup>	89,3 <sup>c/C</sup>	81,7 <sup>bc/B</sup>
2 h	67,0 <sup>c/A</sup>	88,6 <sup>c/C</sup>	68,1 <sup>c/A</sup>	90,3 <sup>c/C</sup>	84,1 <sup>c/B</sup>
24 h	71,1 <sup>d/A</sup>	90,5 <sup>d/C</sup>	74,0 <sup>d/A</sup>	93,0 <sup>d/C</sup>	89,7 <sup>d/B</sup>

Figure 3: Degree of Conversion at different times after light activation. Same small letters denote groups that are not significantly different by columns. Same capital letters denote groups that are not significantly different by rows.

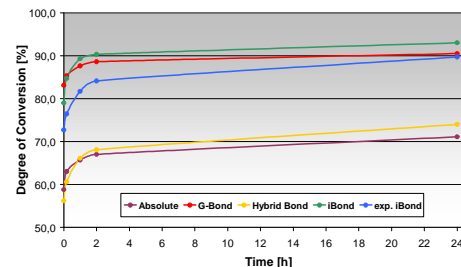


Figure 4: Degree of Conversion [%] versus Time [h]

### 2. Enamel Bond Strength:

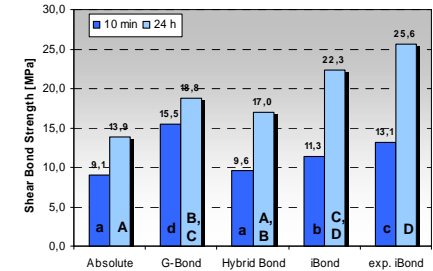


Figure 5: Shear Bond Strength [MPa] after 10 min and 24 h water storage (same letters denote groups that are not significantly different)

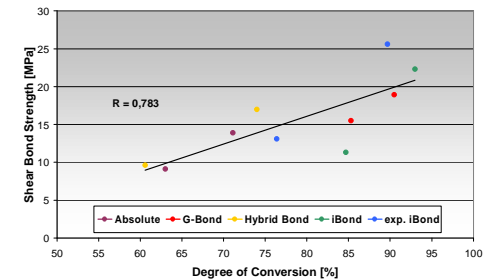


Figure 6: Shear Bond Strength [MPa] versus Degree of Conversion [%]

## Conclusion:

Both, degree of conversion of adhesives and shear bond strength to enamel depend on time of testing.  
Apart from G-Bond the degree of conversion of the adhesives increases by about 15 % within 24 h. DC of G-Bond increases by 8 %.  
G-Bond shows the highest initial DC, Absolute and Hybrid Bond the lowest.  
After 1 hour, nearly all double bonds have been reacted. The DC is approximately the same as after 24 h.  
After 24 h G-Bond, iBond and the exp. iBond show higher DC than Absolute and Hybrid Bond.  
For all adhesives, apart from G Bond, shear bond strength to enamel is significantly lower after 10 min than after 24 h.  
G-Bond shows similarly high SBS values at 10 min and 24 h after light activation.  
After 24 h the experimental iBond adhesive mediates the highest shear bond strength.