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DYNAMIC MECHANICAL ANALYSIS OF DENTAL COMPOSITES.

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Introduction:

Oral temperatures vary between 0°C and 80°C. Dental restorations were loaded with temperatures between 5°C and 55°C, influencing the mechanical properties of the matierials.
The aim of this in-vitro study was to examine the temperature dependence of the storage modulus of dental veneering composites.

Materials and methods:

Rectangular specimens (height: 2mm, width 2mm, length 20mm) were made of dental veneering composites (Tab. 1).
All materials were prepared according to the manufacture's instructions with the recommended curing devices.

The temperature dependent storage modulus (E' [MPa]) (Fig. 1) was determined with a dynamic mechanical analyzer (DMA 242, Netzsch, G; Fig. 2) under air atmosphere. The specimens were subjected to a temperature program between 0°C to -100°C to 200°C with a cooling/heating rate of 10K/min.
All samples were loaded (Fig. 3) with a sinusoidal oscillation of 5, 10 and 20 Hz.
From the results mean and standard-deviation were calculated and statistical analysis was performed (One-way ANOVA; p=0.05).
The results at 0°C, 25°C, 37°C and 55°C are shown.

$$|E^*| = \frac{F_a}{L_a} g \qquad E' = |E^*| \cos\delta \qquad E'' = |E^*| \sin\delta \qquad \tan\delta = \frac{E''}{E'}$$

Fig. 1: Formulas to calculate the complex modulus E*, the storage modulus E´, the loss modulus E´´ and the loss factor tan δ.

material	manufacturer
Adoro	Ivoclar-Vivodent, FL
Belleglass	Girrbach, G
Conquest	Jeneric&Pentron, USA
Dialog	Schütz Dental, G
Epricord	GC, J
Signum	Heraeus-Kulzer, G
Sinfony	3M Espe, G
Solidex	Shofu Dental, G
Thermoresin	GC, J

Tab. 1:
materials and manufacturers

Fig. 2:
Netzsch DMA 242

Fig. 3:
three-point bending sample holder

Results:

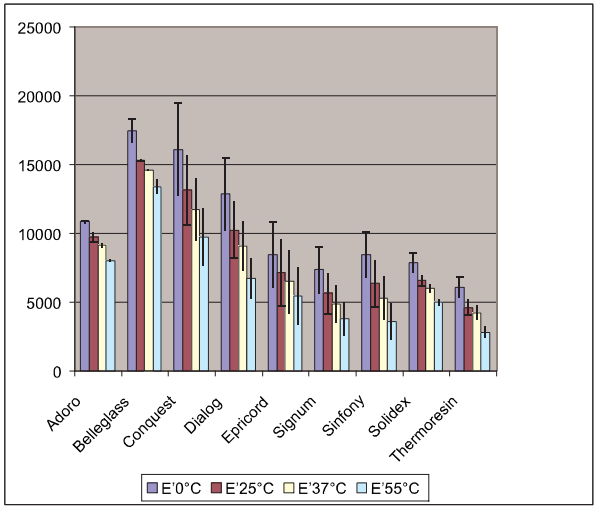

Fig. 4: mean and standard deviation of storage modulus E´ [MPa] at 0°C, 25°C, 37°C, 55°C

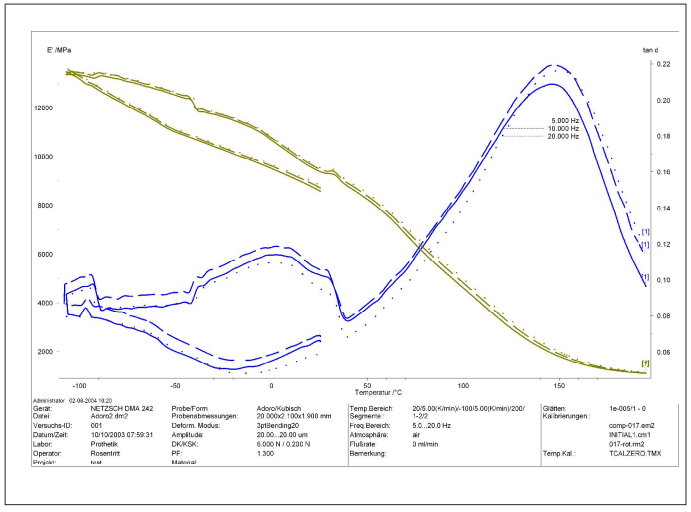

Fig. 5: DMA graph example (Adoro)
E´ and tan δ between -100°C and 200°C

E0/E25/E37/E55	Adoro	Belleglass	Conquest	Dialog	Epricord	Signum	Sinfony	Solidex
Belleglass	x/x/x/x							
Conquest	x/x/x/x	x/x/x/0						
Dialog	x/x/x/x	0/0/0/0	x/x/x/x					
Epricord	x/x/x/x	0/0/0/0	0/0/x/x	x/x/x/x				
Signum	0/0/0/0	0/0/0/0	0/0/0/0	0/0/0/x	x/x/x/x			
Sinfony	x/0/0/0	0/0/0/0	0/0/0/0	x/x/x/x	x/x/x/x	x/x/x/x		
Solidex	0/0/0/0	0/0/0/0	0/0/0/x	x/x/x/x	x/x/x/x	x/x/x/x	x/x/x/x	
Thermoresin	0/0/0/0	0/0/0/0	0/0/0/0	0/0/0/0	x/x/x/x	x/x/x/x	x/x/x/x	0/0/0/x

Fig. 6: statistical analysis (One-way ANOVA; p=0.05), x = significant, 0 = not significant

Conclusion:

The mechanical properties varied by about 50%. The lowest storage modulus was found for Thermoresin, the highest results for Belleglass. In the clinical operative temperature range between 0°C and 55°C all materials showed a decrease of storage modulus with increasing temperature.