

Introduction

The objective of this study was to investigate the influence of post-curing and the vacuum/pressure process on the flexural strength of fiber-reinforced composite bars.

Material and methods

Ninety bars with the dimension of 25x4x2 mm (l,h,w) were fabricated (Vectris "Pontic" system (Ivoclar, Schaan, FL).

Group A (n=30): the bars were light-cured during a vacuum/pressure process in the Vectris-VS-1 device and post-cured for 22min in the Targis-Power device at 95°C. In order to optimize the filler content drains were constructed in the bottom of the molds so that the surplus matrix could be pressed out during the vacuum/pressure process. The group A process is recommended by the manufacturer.

Group B (n=30): the bars were cured using only the vacuum/pressure device VS-1. The molds did not have drains for the surplus matrix. The process lasted 10min.: step 1. air evacuation, step 2: vacuum/pressure (150mbar), step 3: vacuum/pressure and light, step 4: air re-entry.

Group C (n=30): the bars were only light- and heat-cured in the Targis Power device without vacuum/pressure. The entire process lasted 22min.: step 1: light-curing, no heat for 10min., step 2: light-curing and slowly heating up to 95°C, step 3: light-curing and heating at constant 95°C for 7 min., step 4: light-curing and slowly cooling to room temperature (5 min).

The bars were randomly assigned into three subgroups of 10 bars. One part was stored for 24h in distilled water, the next was thermal-cycled (TC: 6000 x 5°C / 55°C, changing every 2 min.), and the third subgroup was stored 30d in water. Then from all groups, the fracture strength was determined using a three-point bending test (Fig.1, Fig.2).

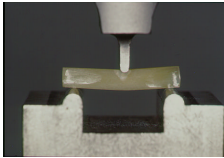


Fig.1: fracture test

$$\sigma = \frac{3 F \times l}{2 b \times h^2}$$

F = fracture strength
l = length
b = width
h = height

Fig.2: formula of flexural strength

$$V_g = \frac{\frac{W_g}{\rho_g}}{\frac{W_g}{\rho_g} + \frac{W_r}{\rho_r}}$$

Fig.3: formula of fiber volume content

W_g = weight % glass fiber
V_g = vol % glass fiber
W_r = weight % resin
ρ_g = density glass fiber (2.43g/cm³)
ρ_r = density resin (1.18g/cm³)

legend of Fig.3

The glass fiber content (vol%) was verified by incinerating the polymer matrix of the bars for 1h at 700°C. The weight before and after the incinerating process was measured using the beam balance Sartorius R160P (Sartorius, Göttingen, G.) and the fiber content was calculated using the formula described in Fig. 3.

Results

	median	Q ₁	Q ₃
A 24h	521	509	555
A TC	501	469	519
A 30d	464	438	464
B 24h	289	264	323
B TC	254	207	280
B 30d	412	405	441
C 24h	469	452	497
C TC	446	430	470
C 30d	423	403	445

Tab.1: flexural strength N/mm²

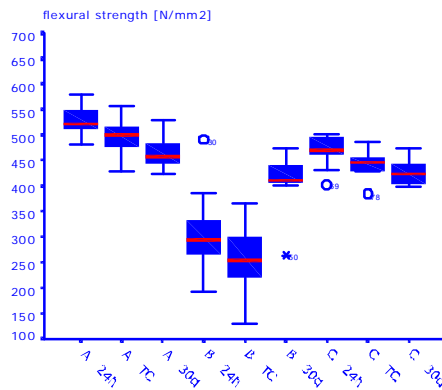
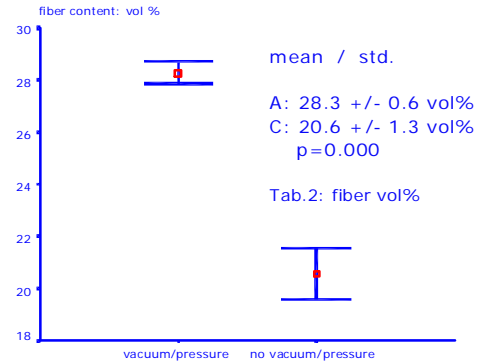


Fig.4: boxplots depict median, Q₁,Q₃ of flexural strengths



Tab.2: fiber vol%

Fig.5: error bars of the fiber volume content: mean, 95% CI

The fiber content was significantly higher using the vacuum/pressure device (Fig.5). However, the flexural strength values were only significantly improved after 24h and TC in comparison to method B. After longer period of water storage, there were no statistical significant differences within the flexural strength of group A, B and C. Group C indicated that post-curing had a greater influence on the flexural strength than the vacuum/pressure process (Fig.4).