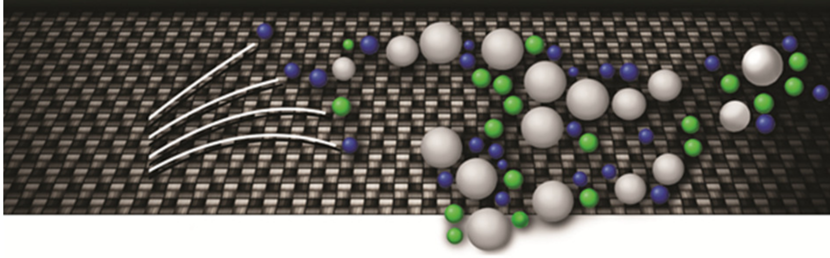
Influence of chemical-stitching binder technology on preform permeability



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Introduction

For the fixation of preforms during RTM-manufacturing mainly adhesive binders are used, which are applied planar between the textile layers. Previous investigations showed, that the planar application of binder leads to a reduction of preform permeability at the infiltration process. In the following study a new preform fixation approach, called “Chemical Stitching”, is introduced and its influence to permeability is characterized. The „Chemical Stitching“ approach is based on the local application of reactive and matrix compatible binder systems in between the dry textiles. The single process steps are illustrated in Figure 1.

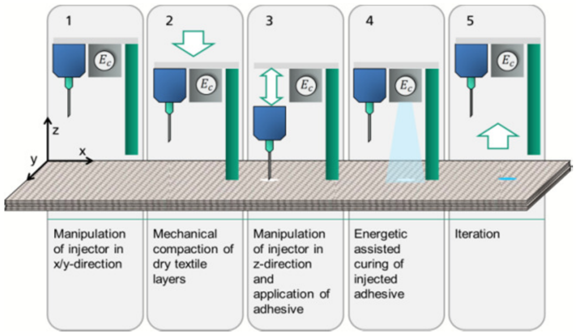

Figure 1: *The Chemical Stitching process and its process steps*

Methodology

Locally fixed preforms using the “Chemical Stitching” fixation approach (Figure 2) are tested in a permeability benchmark against preforms fixed by two types of planar applied binders (Epoxy binder powder, Co-Polyamid binder fleece). Therefore a quasi unidirectional glass fibers woven fabric (425g/m²), is used. Base for the preform is a stack of 6 layers in 0° direction. To further determine the influence of binder quantity the layers are applied respectively with a binder content of 6, 10 and 12 g/m². The not bindered layup is used as reference.

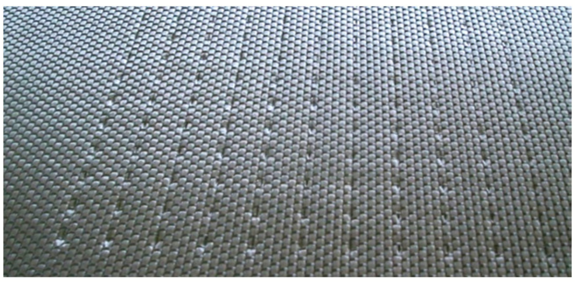

Figure 2: *Preform locally fixed by using “Chemical Stitching” approach*

Results

In Figure 3 the results of permeability measurements in 0°-direction (K_1) are presented. The reference sample without binder has the best permeability. The permeability deteriorates with increasing binder amount for all three kinds of binders.

Especially at low binder amount, parallel to the fibers (K_1-direction), the samples prepared with the “Chemical Stitching” technology show a significant better flow behavior than the aerial bindered preforms.

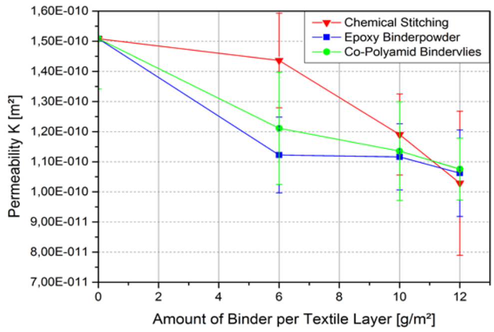

Figure 3: Permeability depending on binder system at 0° fiber orientation

Normal to fibers (K_2), see Figure 4, the permeability reduces with increasing binder amount, too. But here the permeability of planar bindered samples is slightly higher than of the samples fixed by “Chemical Stitching”. Especially at a binder amount of 12g/m².

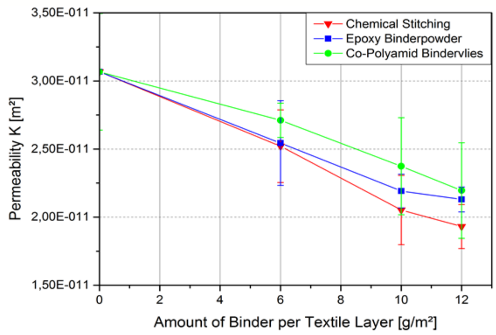

Figure 4: Permeability depending on binder system at 90° fiber orientation

Discussion and Further Research

By haptic perception of the preforms, this is quite a surprising result because the chemical stitched ones feel less compact than the others. That should result in better permeability in both directions. To understand it is necessary to take a closer look at the chemical stitching points. The adhesive binder in each point spreads out elliptically, mainly in fiber direction. These adhesive volumes cannot be infiltrated from the test fluid and could act like local disorders in the flow front and result in pressure losses. The drag coefficient of these volumes at the 0°-preforms is significantly less than the 90°-preforms where the major axis of the ellipse is normal to the flow direction. That could explain why the advantages of chemical stitching technology in K_1-direction cannot be transferred to K_2.

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