INSIDE-OUTSIDE DENSIFICATION OF CARBON FIBER PREFORMS BY ISOTHERMAL, ISOBARIC CVI

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The isothermal, isobaric chemical vapor infiltration (CVI) of carbon is the most important process for the production of carbon fiber reinforced carbon (CFC). Although it is used for decades, this process was never understood because it was generally assumed to be strongly diffusion limited [1,2]. Recent model studies based on CVI of capillaries of various diameters and lengths showed the opposite, in other words much higher deposition rates in the depth of the capillaries compared to the mouth (inside-outside densification) [3-6].

The relevance of these results for the infiltration of carbon fiber preforms to produce CFC was investigated using a carbon fiber felt with a fiber volume fraction of 7 % and a 2D carbon fiber preform (0/0/90/90) with a fiber volume fraction of 22.5 %. Infiltration depths of 21mm and 42mm were studied at temperatures of 1070 and 1095 °C and methane pressures ranging from 5 to 30 kPa. An inside – outside densification was confirmed up to an infiltration depth of 42 mm (felt) and a methane pressure up to 26 kPa (2D preform).

Results obtained with the felt by infiltration from both sides (infiltration depth: 21 mm) and from one side (infiltration depth: 42 mm) are presented in Fig. 1 (a) and (b), respectively. Bulk densities decreasing from the center (a) or the sealed side of the preform (b) to the surface are a clear indication of an inside – outside densification. Studies at various methane pressures showed that a pressure increase may enhance the inside – outside densification. These results on the influence of infiltration depth and methane pressure are a clear confirmation of the results of the model studies. This indicates that CVI of carbon from methane was misinterpreted all these years.

Using appropriate parameters for an inside – outside densfication carbon fiber preform can be densified to bulk densities above 1.8 gcm^{-3} in maximal five days compared to weeks or months necessary in industrial processes. Moreover, it is possible to control the texture of the infiltrated matrix carbon.

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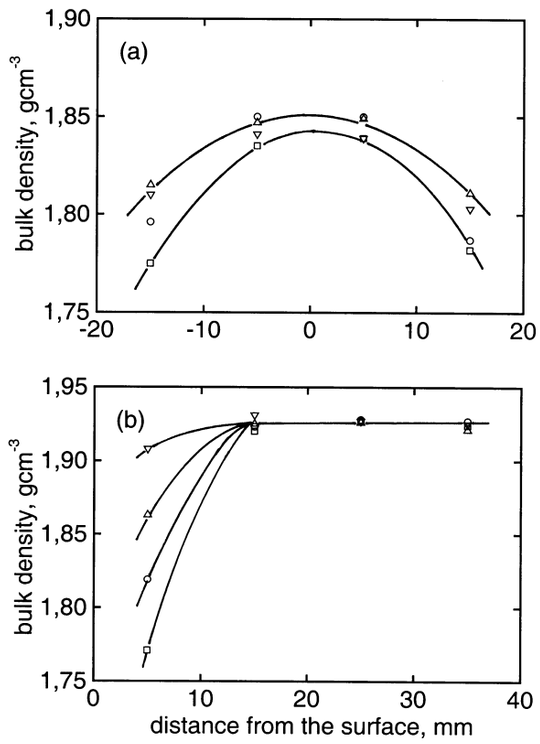

Fig. 1 Bulk densities as a function of the distance from the surface (infiltration depth) obtained with the carbon fiber felt after an infiltration time of 120 h at 1070 °C, 20 kPa, 0.1 s residence time. (a) Infiltration from both sides. (b) Infiltration from one side. (□), (○), (▽), (△): bulk densities at increasing heights of the felt (along the gas flow).