KINETIC ANALYSIS OF THE LOW TEMPERATURE CVD OF SILICON / SILICON CARBIDE FROM METHYLTRICHLOROSILANE / HYDROGEN FOR THE CERAMIZATION OF BIOMORPHIC CARBON PREFORMS

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Cellular materials like wood are being used for the production of specific high porous lighter, stronger and more resistant engineering materials. The CVI-R process is a very promising technology for the ceramization of porous cellular templates, because of the relative low deposition temperature. By this technique the exact macro as well as microstructure of the original biomorphic structure is prevailed in the ceramic. For the production of SiC ceramics from biomorphic materials by CVI-R Methyltrichlorosilane/Hydrogen (MTS/H_2) is used as a precursor.

In the present work, the deposition of Si enriched SiC from MTS/H_2 in the low temperature region (800°C – 875°C) is investigated and a mathematical description of the kinetic of the deposition process is presented. As a first step, the Si to C ratio of the deposits is determined experimentally at different process parameters as shown in figure 1.

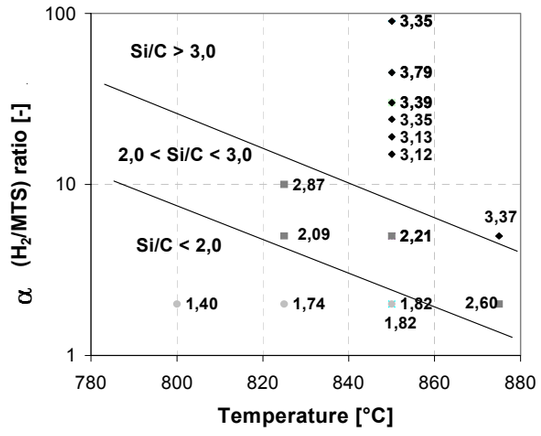

Fig. 1: Composition of the deposits at different temperatures and H_2/MTS ratios

Based on thermodynamic calculations of the equilibrium concentration of different Si bearing and C bearing species a detailed kinetic model including 8 homogeneous gas phase reactions and 10 heterogeneous surface reactions is presented. The deposition of Si and C from MTS/H_2 is simulated in a tubular hot wall reactor using the CHEMKIN software.

Figure 2 shows the calculated gas phase composition of the main Si bearing species responsible for the Si deposition along the reactor axis.

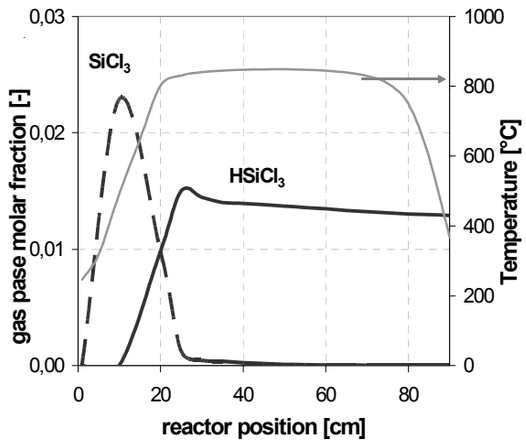

Fig. 2: Gas phase composition of the main Si-bearing species along the reactor axis.

The results of the simulation with the model are shown in figure 3. The modeled deposition rate curves along the reactor are compared to the experimental curves for given reaction conditions. For the Si deposition two cases are considered: In the first case only $SiCl_3$ is assumed to adsorb on the surface. In the second case the adsorption of $SiCl_2$, $SiCl_3$ and $HSiCl_3$ are included in the model. The independent deposition of Si and C is modeled by the inclusion of two different types of surface sites: one type responsible for the Si growth, where the Si-bearing species adsorb, and another for the adsorption of the C species. In this way it is possible to include in the model the different ratios of Si/C in the films at different reaction conditions.

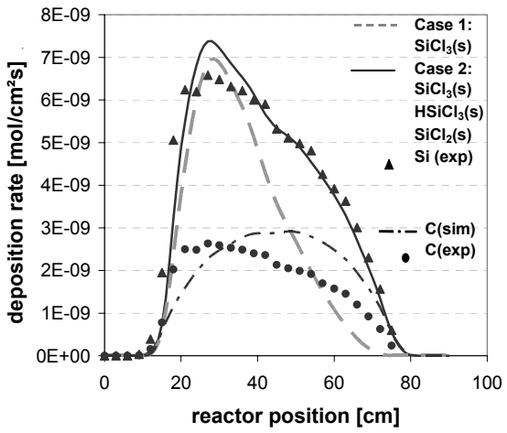

Fig. 3: Calculated model curves compared to experimental data (points) for the separated Si and C deposition rates.