PROCESSING, PERFORMANCE AND PROCESS MODELING OF PRECERAMIC POLYMERS

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The pyrolysis yield of preceramic polymers is affected by its processing through curing. Evaporative losses, degree of cure, molecular weight distribution, structure, functional groups and mechanical damage all affect the observed performance of preceramic polymers. As preceramic are pyrolyzed, they undergo multiple thermal decomposition reactions. Differences in the initial composition leads to differences in thermal decomposition of the polymers and evolved gases. These differences then affect the evolution of density of the polymers in a ways that dramatically affect their volume yield and pore pressures as a function of pyrolysis temperature. Experimental data indicated that the material models addressing volumetric changes during pyrolysis must be able to address both the temperature and time at temperature dependent changes in mass and material density, because density is not a simple function of mass yield. The model analysis of the materials performance revealed two major spikes in the rate of volume shrinkage where the first is initially driven by changes in mass but is quickly overcome by density's dominant contribution to changes in volume for both peaks. This indicates the importance changes in material density in predicting the volume yield of preceramic polymers. Calibration with experimental data is essential to correctly modeling the stresses and strains that develop during processing.

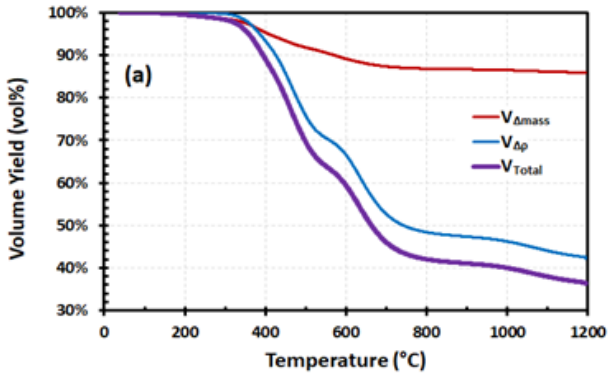

Figure 1 – Contributions of mass loss and density to the volume yield of a cured polycarbosilane (SMP-10), during pyrolysis.

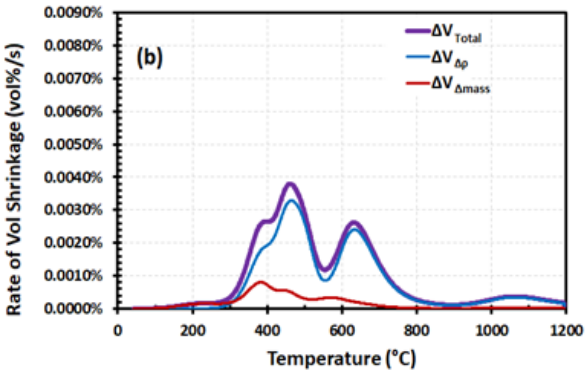

Figure 2 – Contributions of mass loss and density to the shrinkage rate of a cured polycarbosilane (SMP-10), during pyrolysis.

Thomas S. Key, Dipen Patel, Garth B. Wilks, and Michael K. Cinibulk, "Modeling the Pyrolysis of Preceramic Polymers: A Kinetic Study of the Polycarbosilane SMP-10." J. Eur. Ceram. Soc., (2021) https://doi.org/10.1016/j.jeurceramsoc.2021.06.011.

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