4cw Study and Utilization of Microscale Phenomena for Operation of Microscale Devices and High-Temperature Microreactors

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The use of microscale devices has grown rapidly in the last decade because of the advantages these devices have over conventional devices. For instance, the larger surface area-to-volume ratios encountered at the microscale lead to the greater magnitude of surface forces relative to body forces, leading to phenomena that are not seen at the macroscale. Also, the shorter distances over which heat and mass transfer occur lead to improved transport at the scale of interest and faster transient behavior. Microreactors for H_2 production are promising portable power sources. H_2 can be produced by reactions such as the decomposition of NH_3 or the steam reforming of hydrocarbons. High temperatures are required for both faster reaction kinetics and higher equilibrium conversion. Because heat must be supplied for this endothermic reaction, macroscale reactors are often limited by the heat transfer rate from a heat source to the reacting gas. By reducing the length scale over which the heat is transferred to the reactants, the heat transfer rate is increased, thus increasing the possible H_2 production rate. This poster will describe efforts in fabricating macroporous SiC and SiCN catalyst supports with high-temperature stability and tailored pore size[1], and the integrating of these catalyst supports within an alumina housing. NH_3 will also be decomposed within these reactors at temperatures up to 1000 °C to show their use for H_2 production. Interesting phenomena result from the importance of surface forces relative to body surfaces encountered at the microscale. Typically when fluids of different density flow side by side, the pressure mismatch at the vertical interface leads to immediate reorientation of the interface between the fluids such that the less dense fluid flows on top. At the microscale, however, the viscous force becomes more important and the reorientation occurs more gradually. This phenomenon is important for microfluidic devices using fluids of different densities, as devices such as T-sensors depend on the steams flowing side-by-side with a vertical interface. The work described here relates the extent of reorientation of the interface to two dimensionless numbers, *Fr*, the square root of the ratio of inertial to gravitational forces, and Re/Fr^2, the ratio of gravitational to viscous forces. The resulting equation shows that the extent of reorientation is independent of the ratio of inertial to gravitational forces, and aids in the design of microdevices using fluids of different densities by establishing conditions under which the reorientation of the interface can be avoided.

[1] Sung, I.-K., Christian, Mitchell, M., Kim, D.-P., Kenis, P. J. A., *Advanced Functional Materials*, accepted.