Effects of flow rate and kinetic quenching on the transition of flame regimes in mesoscale combustion

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Microscale chemical reactor and power generation yield a challenge in the study of combustion in meso and micro scales. Because of the strong flame-wall interaction at the reduced scale, recent studies have shown that there are many new unique combustion phenomena in mesoscale combustion. In the present study, the effects of channel width, flow velocity, and radical quenching on the transition between flame regimes in mesoscale combustion are numerically investigated. The two-dimensional flame bifurcations are successfully predicted by a newly developed two-eigenvalue method. The results showed that channel width has a significant effect on the flame geometry, velocity, and bifurcations (Fig.1). At a large channel width, it is shown that flame is negatively stretched and flame velocity increases dramatically with the increase of the channel width. Furthermore, tt is shown that a large channel yields a smooth transition from the fast flame regime to the slow flame regime However, at a small channel width it is shown that flame is often positively stretched. In addition, a decrease of the channel width or fuel concentration results in either a flame extinction or a transition to a new flame branch. Furthermore, the results demonstrate that flow velocity has a significant impact on the flame propagation speed and bifurcations. In addition, it is shown that radical quenching greatly accelerates the quenching of the fast flame. The results qualitatively give a good explanation to the experimental observation.

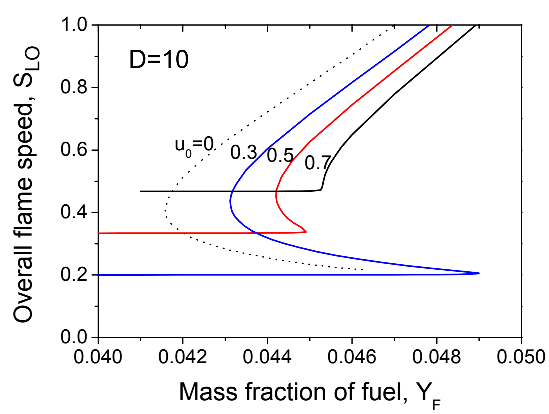

Fig.1 Dependence of flame speed on fuel concentration