Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

The impact of ignition on the occurrence and dynamics of multi-stage flames under shock tube conditions TIANHAN ZHANG, YIGUANG JU, Princeton University — The laminar flame speeds and structures of ignition-assisted cool and warm n-heptane/air flames are studied computationally and analytically. The primary objective is to understand the effects of the ignition Damkohler number, mixture temperature, equivalence ratio, and pressure on the dynamics and structures of cool and warm flame propagation under shock tube conditions. Different transitions among cool, warm, and hot flames are examined. The results show that both cool and warm flame structures and propagation speeds change dramatically with the increase of the ignition Damkohler number and are affected by the initial temperature, equivalence ratio, pressure, and flame regimes. Furthermore, within the hot flame flammability limits, it shows that the cool flame speed has a non-monotonic dependence on the initial mixture temperature due to the negative temperature coefficient (NTC) effect, while the hot flame speed is divergently different and only increases monotonically with the initial temperature. Finally, compared with recent flame speed measurements using the shock tube, the simulation agrees well with the experimental data and demonstrates clearly how ignition and multi-stage flames affect the experimental observation and result in the NTC behavior.

Tianhan Zhang
Princeton University

Date submitted: 01 Aug 2019 Electronic form version 1.4