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Program and abstracts

14:15 - PROPAGATION MECHANISMS OF HETEROGENEOUS DETONATIONS

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A rational theory of steady-state heterogeneous detonation including finite-rate multistep localized ignition and combustion chemistry and group-screening effects of drops in suspensions has been developed. The theory is capable of predicting the effects of mixture equivalence ratio, drop size, fuel type, active additives, fuel prevaporization degree, initial pressure and temperature, etc. on detonation structure and limits. Possible mechanisms of detonation propagation are discussed. The reaction zone of the heterogeneous detonation was found to consist of three characteristic periods, namely, (*i*) induction period, (*ii*) period of fast volumetric autoignition and combustion of some finite mass of accumulated fuel vapor, and (*iii*) period of diffusion-controlled frontal combustion of fuel drops. At low equivalence ratios on the order of 1, the energy release in the heterogeneous detonation is governed by the frontal diffusion-controlled combustion, which results in relatively long reaction zones and high sensitivity of the detonation velocity and reaction zone structure to the equivalence ratio and drop size. At very large equivalence ratios closer to the fuel-rich detonability limit, the energy release is governed by the fast volumetric autoignition and combustion of some amount of accumulated fuel vapor, which leads to very short reaction zones and low sensitivity of the detonation velocity and reaction zone structure to the equivalence ratio and drop size. At intermediate equivalence ratios, the energy release is governed by a combined frontal and volumetric mechanism with the comparable contributions of both modes to the total reaction time. By other words, the mechanism of energy release in the heterogeneous detonations depends on the suspension density: increase in the suspension density results in the transition from diffusion controlled to the kinetically controlled mode of energy deposition.

Among the unresolved issues lacking in the theory one has to mention various transient and multidimensional phenomena inherent in realistic heterogeneous detonations. First of all, these are the issues dealing with simulating the intrinsically unsteady (pulsating) mode of detonation propagation observed experimentally. The heterogeneous detonations are known to exhibit localized explosions in the reaction zone giving rise to a complex multidimensional wave structure resembling the irregular cellular structure of gaseous detonations. The other important unresolved issue is the detonation response to various disturbances like spatial nonuniformity of drop suspension density, drop size distribution, fuel vapor concentration, etc. The last but not least is the issue of detonation initiation.

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