conferenceseries.com

J Phys Chem Biophys 2017, 7:3 (Suppl)
DOI: 10.4172/2161-0398-C1-023

2nd International Conference on
PHYSICS
August 28-30, 2017 Brussels, Belgium

Analysis of thermos-diffusive cellular instabilities in continuum combustion fronts

Hossein Azizi, Sebastian Gurevich and **Nikolas Provatas**
McGill University, Canada

We explore numerically the morphological patterns of thermo-diffusive instabilities in combustion fronts with a continuum fuel source, within a range of Lewis numbers and ignition temperatures, focusing on the cellular regime. For this purpose, we generalize the recent model of Brailovsky et. al. to include distinct process kinetics and reactant heterogeneity. The generalized model is derived analytically and validated with other established models in the limit of infinite Lewis number for zero-order and first-order kinetics. Cellular and dendritic instabilities are found at low Lewis numbers. These are studied using a dynamic adaptive mesh refinement technique that allows very large computational domains, thus allowing us to reduce finite-size effects that can affect or even preclude the emergence of these patterns. Our numerical linear stability analysis is consistent with the analytical results of Brailovsky et. al.. The distinct types of dynamics found in the vicinity of the critical Lewis number, ranging from steady-state cells to continued tip-splitting and cell-merging, are well described within the framework of thermo-diffusive instabilities and are consistent with previous numerical studies. These types of dynamics are classified as "quasi-linear" and characterized by low amplitude cells that may be strongly affected by the mode selection mechanism and growth prescribed by the linear theory. Below this range of Lewis number, highly non-linear effects become prominent and large amplitude, complex cellular and seaweed dendritic morphologies emerge. The cellular patterns simulated in this work are similar to those observed in experiments of flame propagation over a bed of nano-aluminum powder burning with a counter flowing oxidizer. These resemble the dendritic fingers observed in this study, in the limit of low-Lewis number. It is noteworthy that the physical dimension of our computational domain is roughly close to their experimental setup.

hossein.azizi@mail.mcgill.ca