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Effect of carbon content on hypersonic shear layer instability
LUCA MASSA, University Of Texas at Arlington — Thermochemistry interacts with fluid-dynamic processes when kinetic and convective time-scales overlap. Nonlinear parabolized Navier-Stokes equations are applied to the analysis of the instability and transition of carbon containing shear layers in hypersonic conditions. Linear parallel analysis shows an increase in growth rate of magnitude up to 20%, for selected oxygen to carbon molar fractions. Localized maxima in linear growth rates are obtained for temperature close to the characteristic vibrational temperatures of carbon dioxide and for oxygen to carbon fraction of two, indicating potential destabilizing effect of carbon chemistry at high Eckert numbers. An increase in farfield temperature leads to an increase in growth rate, which is more marked at low carbon content. Non parallel effects are primarily related to streamwise relaxation for conditions away from equilibrium. The integrated kinetic energy from the parabolized analysis show a considerable change of kinetic energy growth with carbon content, identifying carbon dioxide as a destabilizing factor and causing energy increase of around 50%. Energy transfers from kinetic to sensible and latent enthalpic modes are analyzed within the parabolized evolution.

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