



Computational and Experimental Study of Energetic Materials

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Introduction

Most solid rocket fuels are mixtures of an oxidizer and polymer fuel

Typical oxidizer is Ammonium Perchlorate (AP)

Typical fuel is Hydroxy Terminated Poly-Butadiene (HTPB)

There exist strong diffusion flames between AP and polymer fuel

These diffusion flames can control the solid regression rate- a *critical* rocket motor design parameter

Changing the length scale (AP crystal size) can cause large changes in regression rate

Counterflow System

2D diffusion flame difficult

Experimentally: extremely short length scales

Computationally: requires 2D model

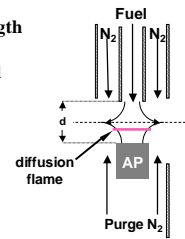
Decided to try 1D counterflow configuration

Works great

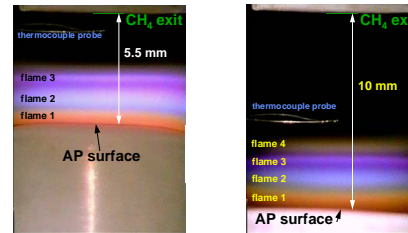
1D flame allows 1D model

Enormous expansion of length scale

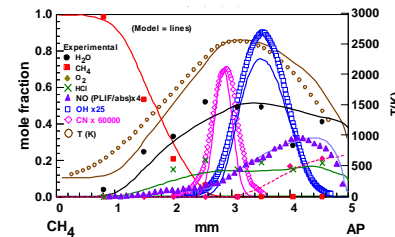
Stationary system



AP / Methane Counterflow Diffusion Flames



Raman and PLIF Profiles: AP / Methane Compared to Model



Research done in collaboration with Dr. R. A. Yetter, Penn State University
Dr. T. P. Parr and Dr. D. Hanson-Parr, NAWC, China Lake, CA
Research supported by ONR

Why study AP with CO+H2?

Fine AP fraction in binder makes pseudo premixed "flame"

'Premixed' wrt length scale of big AP

Homogeneous output of these flames burns in diffusion flame with large AP

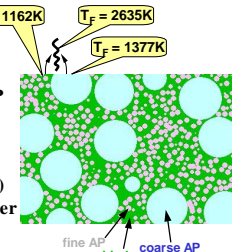
3D composite "simulation"

1 mm x 0.7 mm slice

200 mm coarse, 25 mm fine

85% solids (62% coarse, 38% fine)

Big regions of binder between larger AP crystals

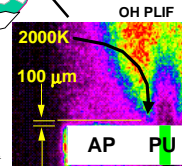
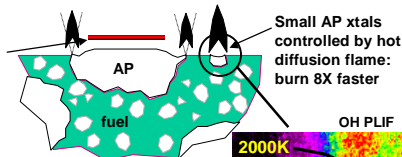


Experimental simulations:

- 1) Region is fuel, say CH₄ or C₂H₄ then
- 2) Region is premixed flame: 53% H₂ + 47% CO now

Background

Large AP xtals controlled by cool self flame, burn slowly



- Important to understand this ballistic controlling diffusion flame
- Ultimate goal: computer
- model that allows design of solid propellant ballistic properties

Video Image of Counterflow Flame

