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Chemiluminescence in Premixed Ammonia-Air Flames

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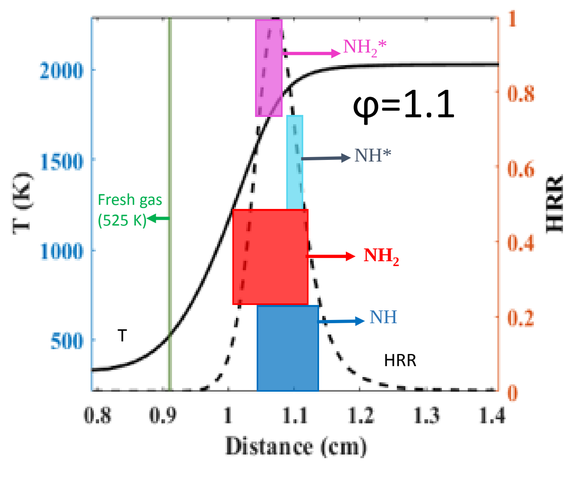
Ammonia combustion is of great interest as it is a zero-carbon fuel and has a high octane rating. However, the flame properties have not been studied well. The objective of this work is to use an economic diagnostic tool to obtain useful data.

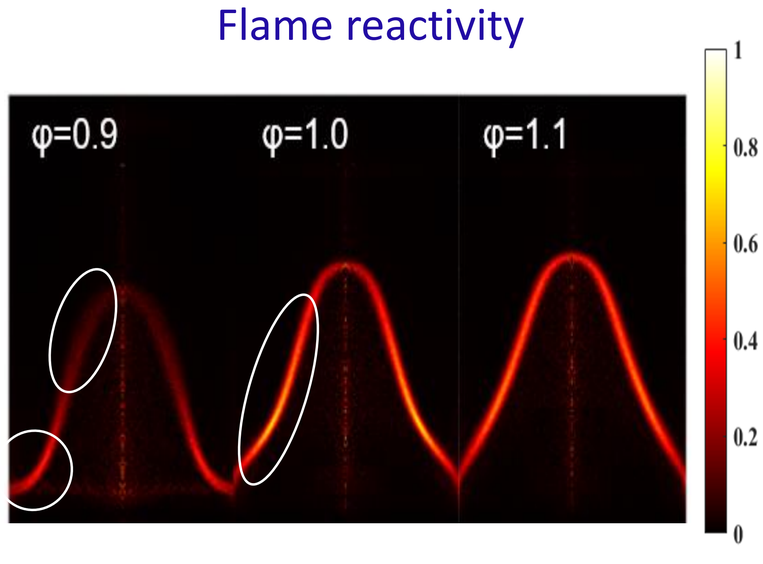
Chemiluminescence is a cheap and non-intrusive diagnostic tool that is widely used to obtain a large range of information pertaining to flame behaviour. In ammonia combustion, NH_2*, NH*, and OH* have been identified as species of relevance.

Heat release rate marker



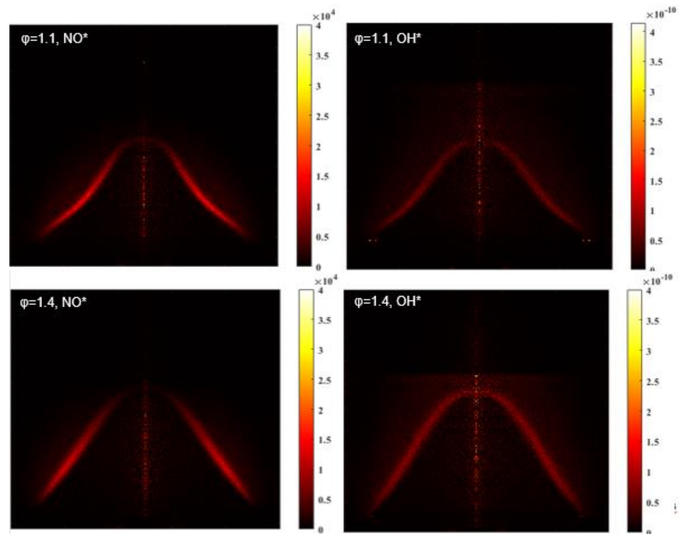
NH* and NH_2* have been identified as the HRR marker pure ammonia flames on a Bunsen burner configuration.

Flame reactivity



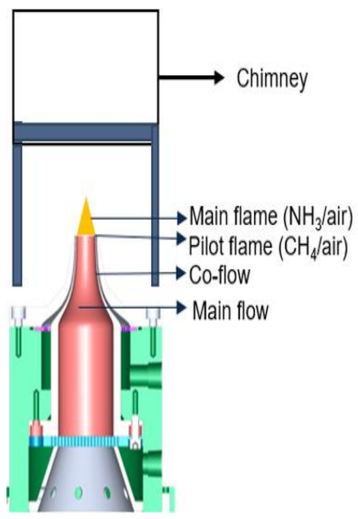
Change of intensity in NH_2* profiles on a Bunsen burner configuration indicating local change of reactivity.

NO emissions

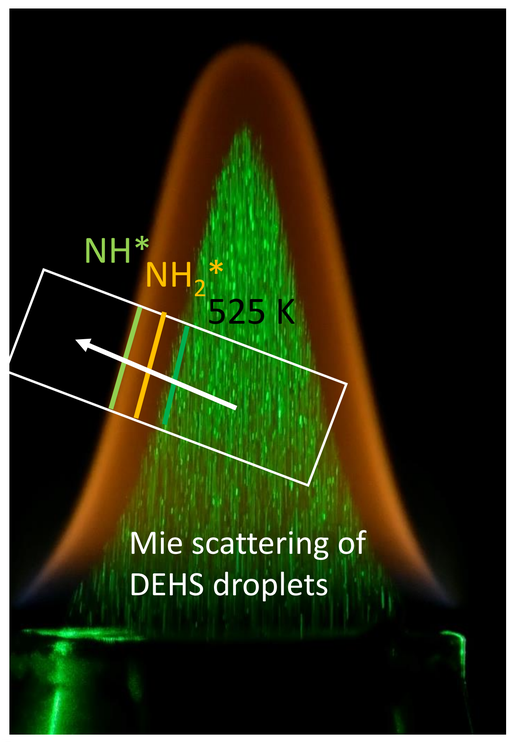


Relative NO* emissions vs corresponding proportional OH* emissions for two different equivalence ratios indicating OH* predictions for relative NO quantities

Chemiluminescence set-up
NH_2* - 632 nm
NH* - 337 nm
OH* - 310 nm



On superimposing NH* and NH_2* inverse abel transformed image with the DEHS droplets evaporating at 525 K, the position of the species can be determined within the flame front



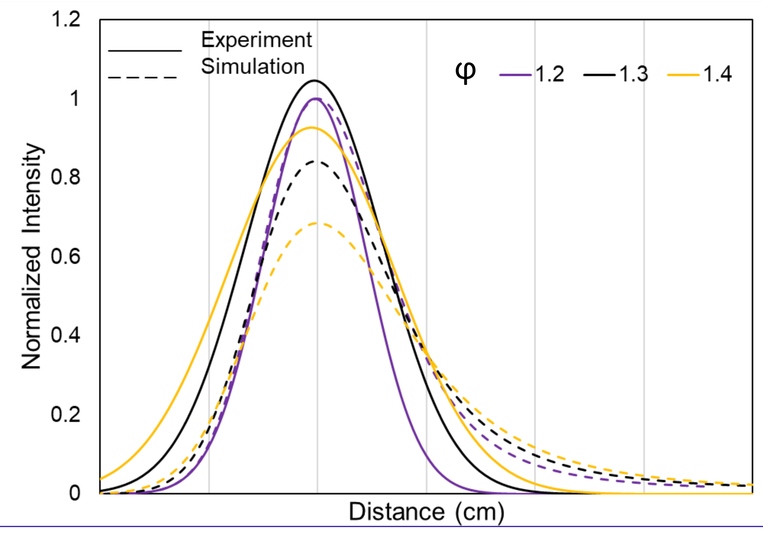
NH_2* sub-mechanism: proposed reactions

$NH_2^* \rightleftharpoons h\nu + NH_2$
$NH_2^* + H_2O \rightleftharpoons NH_2 + H_2O$
$NH_2^* + N_2 \rightleftharpoons NH_2 + N_2$
$NH_2^* + NO \rightleftharpoons NH_2 + NO$

$NH_2^* + Ar \rightleftharpoons NH_2 + Ar$
$NH_2^* + H_2 \rightleftharpoons NH_2 + H_2$
$NH_2^* + Ar \rightleftharpoons NH_2 + Ar$
$NH_2^* + H \rightleftharpoons NH_2 + H$

$NH_2^* + NH_2 \rightleftharpoons NH_2 + NH_2$
$NH_2^* + M \rightleftharpoons NH + H + M$
$N_2H_2 + NH \rightleftharpoons NNH + NH_2^*$
$N_2H_2 + NH \rightleftharpoons NNH + NH_2^*$

$NH + HNO \rightleftharpoons NO + NH_2^*$



Experiment vs simulation

The proposed sub-mechanism can predict the width of the profiles quite well. The peak values depend on the base model. There is still room for improvement. Future work includes proposing sub-mechanism for other species.

Acknowledgement

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