## Exploring the iron oxide nanoparticle combustion synthesis in a wide range of operating conditions

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Iron oxide nanoparticles (NPs) have a wide range of advanced applications, from biomedicine and magnetic resonance imaging to heterogeneous catalysis [1]. Combustion synthesis offers a facile route to scalable synthesis of iron oxide nanoparticles with tailored properties. NPs with engineered functionalities can be realized by varying flame conditions.

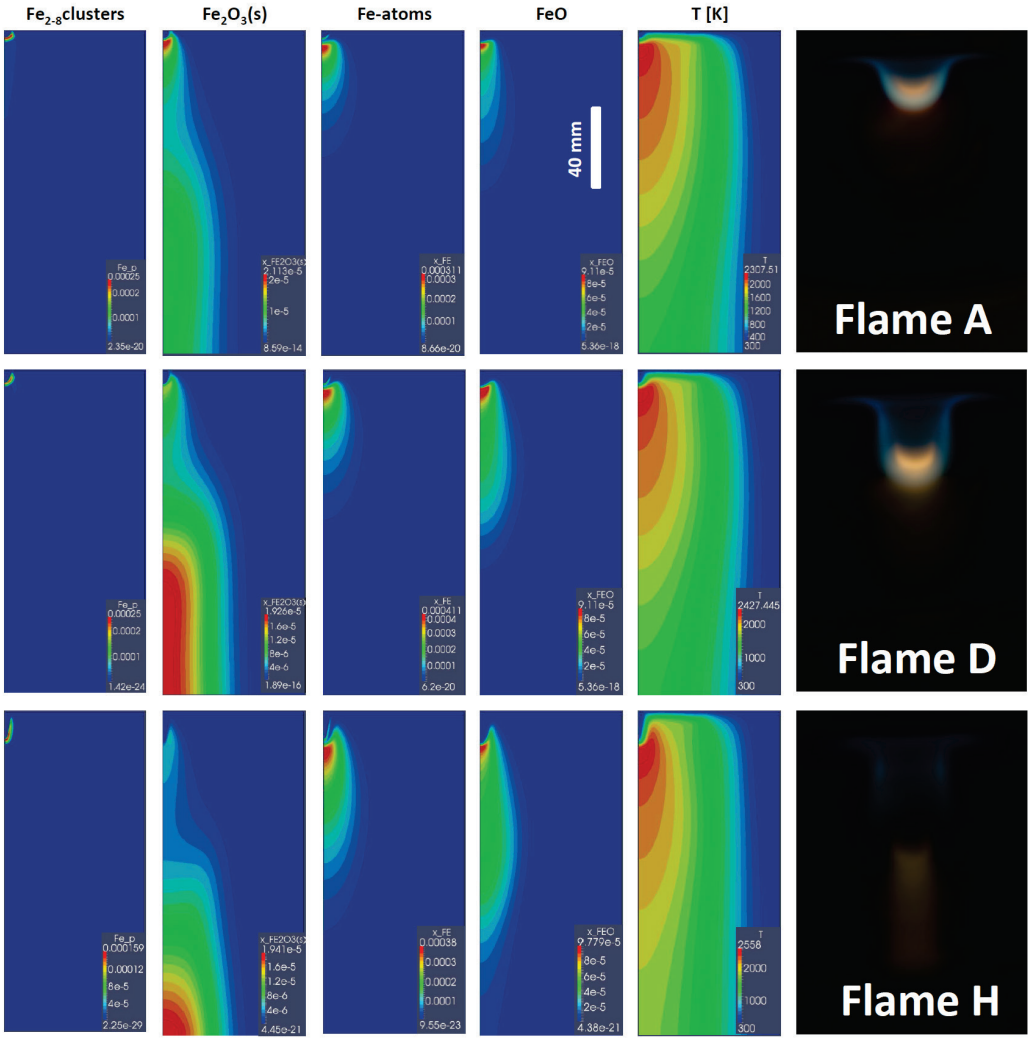


**Figure 1:** Visual appearance of hybrid NP synthesis flame at different gas flow conditions (tabulated as A, D and H) along with 2-D CFD simulation of key species

In this work we have used a hybrid combustion synthesis source flame, where the primary premixed flame on the porous sinter plate provides the energy necessary to support the premixed central flame, doped with the NP precursor for NP fabrication. This configuration allows extremely wide range of operating conditions of the latter with respect to fuel/oxygen ratio, precursor content and total flow rate (see Figure 1). The use of wide range of operating conditions is especially appealing, since while ample evidence on formation of noble metal NPs (e.g. Au, Ag, Pt) in flames is available [2], recent studies indicate that formation of metal clusters (seen for iron oxide NPs) [3-4] may prove to be a general feature of metal oxide formation from premixed flames. This project focuses on integrated experimental (Quartz –Crystal Microbalance –Particle Mass Spectrometry, Laser Induced Fluorescence, Intracavity Laser Absorption Spectroscopy and Cavity Ring Down Spectroscopy) measurements augmented by Computational Fluid Dynamics (CFD) modeling with detailed reaction kinetics and aims to elucidate under which conditions the "metal cluster route" plays an important role. The use of the hybrid flame configuration allows us to explore a wide range of combustion conditions. Our preliminary results indicate that the importance of metal cluster route (associated with prompt NP formation [3-4]) decreases with the increase of the total flow, which is supported by the results from CFD.


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