UNIVERSITÄT DUISBURG ESSEN

Offen im Denken

REACTIVE FLUIDS
Institute for Energy and Materials Processes

Master thesis

„Nanoparticle formation near burning iron particles“

The combustion of metal powders provides heat or electricity without generating CO_2. Oxidized metal particles are reduced with green hydrogen such that the metal particle is recycled. In this work, the combustion of micrometer-sized iron particles is investigated in a dust flame, see Figure 1a. Iron particles are fed into a premixed flame where they heat up, melt, and eventually ignite. The combustion occurs predominantly heterogeneously, i.e., via the diffusion of oxygen into the liquid iron droplet. However, a part of the liquid droplet, around 1-4%, also evaporates into the surroudning. From that, iron-oxide nanoparticles, visualized in Figure 1b by their light extinction surrounding the droplet (black dot), form and ‘get lost’ in the process. The formation occurs from species in the gas phase, Fe and maybe FeO, which oxidize and with increasing distance from the droplet condense into nanometer-sized particles (schematically shown in Figure 1c). To extend the current understanding of nanoparticle formation, laser-induced fluorescence will be applied to visualize gas-phase species, i.e., Fe and FeO, and laser-induced incandescence will be applied to visualize different phases of iron-oxide nanoparticles, i.e., Fe_2O_3/Fe_3O_4 and liquid/solid.

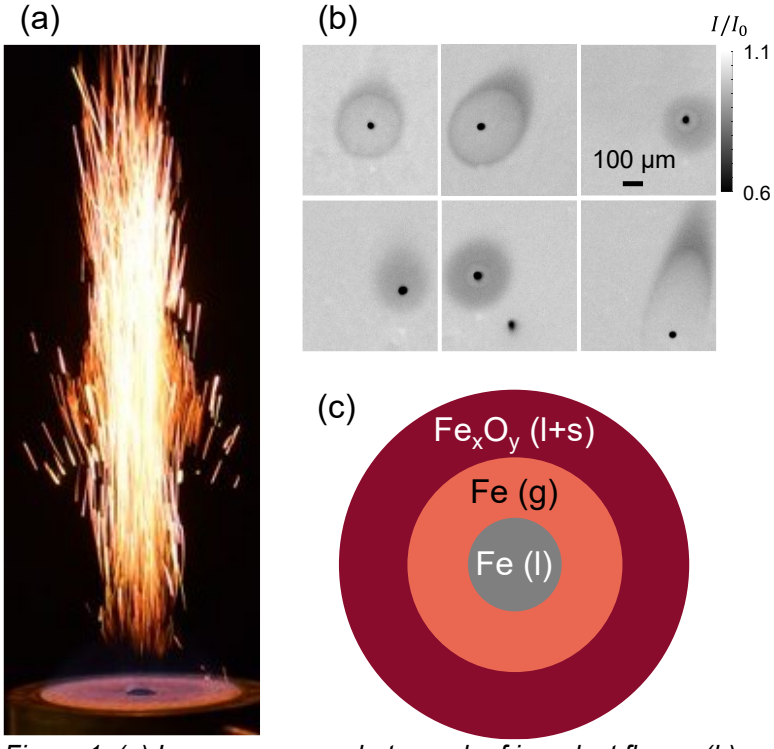

Figure 1: (a) Long-exposure photograph of iron dust flame; (b) Shadowgraphs of single burning iron droplets, surrounded by a cloud of iron-oxide nanoparticles, (c) schematic of iron-oxide nanoparticle formation

Tasks:

- Implementation of the optical layout (laser, optics, cameras)
- Interpretation of the results/images and study of nanoparticle formation from the gas phase

Requirements:

- Interest in optics, phase changes, and experimental work
- Working in MATLAB or Python for processing the results

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