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Metals as Future Carbon-Free Energy Carriers

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Introduction: Micrometric metal particles offer a promising source of sustainable energy. Upon ignition, they generate a significant amount of energy without emitting carbon dioxide. Additionally, this process yields metal oxides that can be regenerated using wind or solar energy. This cyclical system of energy production and recycling enables renewable energy to be stored securely and sustainably, accessible at any needed time or location. This presentation introduces an innovative and promising approach that centers on the high-temperature oxidation of metals. It forms part of a ground breaking technology that has the potential to tackle global warming.

Methodology: In atmospheric air, aluminum particles of sufficient radii burn in a diffusive regime. As aluminum evaporates from the burning droplet, oxidation occurs, resulting in the production of alumina. The presence of this aluminum oxide results in the formation of an oxide cloud, comprising nanometric droplets, which is situated in close proximity to the burning droplet. The comprehensive characterization of this cloud is of paramount importance and can be accomplished with the current experimental apparatus using a backlight and a color camera equipped with a triple band filter.



Fig.1 Typical stability result

Experimental Evaluation: As a result, the alumina particle size profiles and volume fraction profiles around the burning particle are inferred experimentally. Furthermore, the optical thickness of the cloud is directly proportional to its emissivity. A deconvolution procedure that accounts for self-absorption can be employed to determine the local cloud emission, which can then be divided by the local emissivity to obtain the local blackbody emission. By utilizing a blackbody calibration for the camera, a temperature profile can be established at all points within the oxide cloud surrounding the particle, thereby facilitating a comprehensive characterization of this cloud.

Keywords: metal particle combustion, three-color pyrometry, nanoparticle size and temperature profiles

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