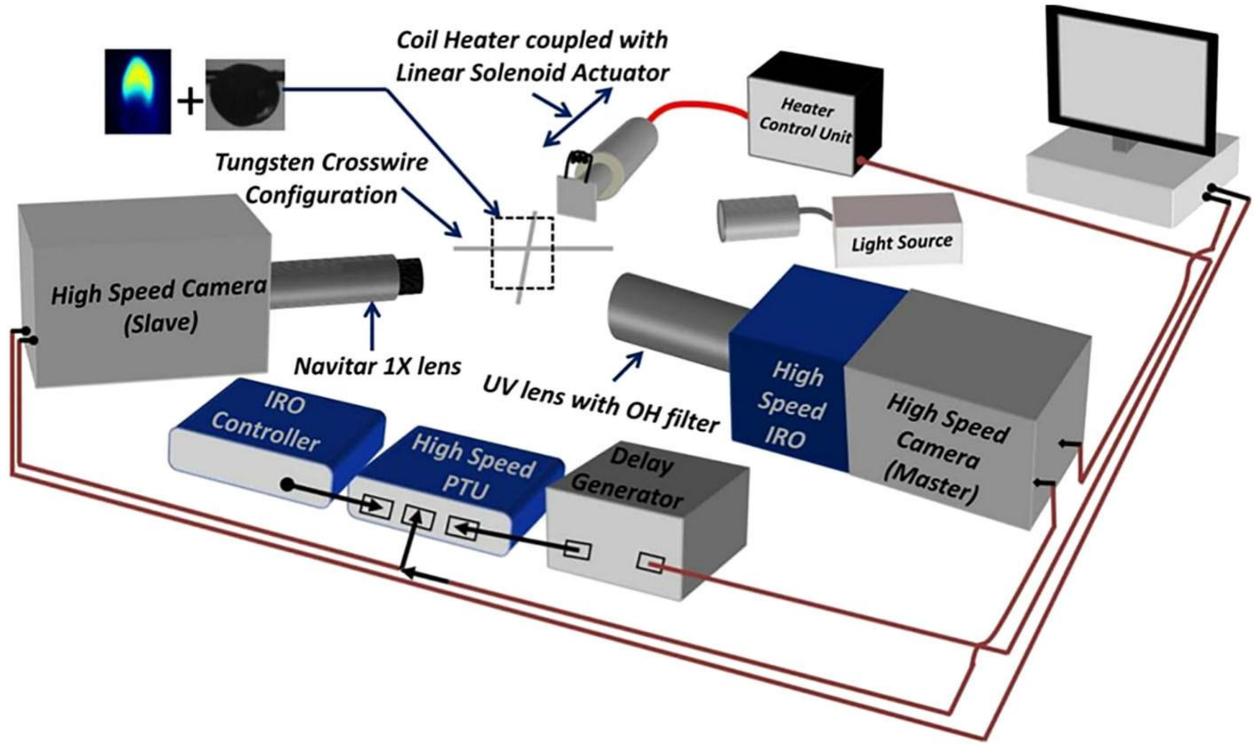

Figure S1. Schematic of the experimental setup comprising of high-speed camera and chemiluminescence imaging systems for simultaneous capture of droplet shape and flame. The imaging system is synced with droplet ignition system (coiled heater coupled with linear solenoid actuator) with a delay generator [1].

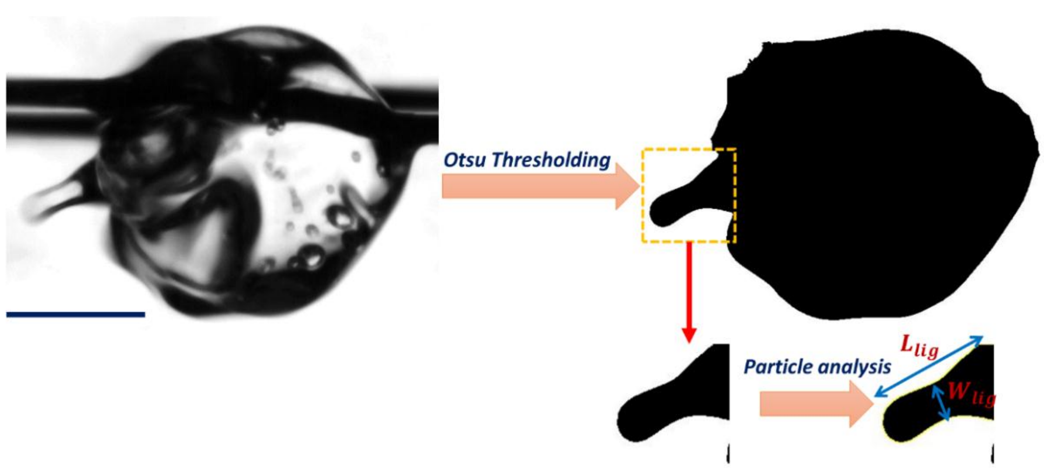

Figure S2. Algorithm followed for evaluating ligament dimension (Scale bar is 0.5mm)

Presence of high temperature flame envelope around the burning droplet impedes an exact estimation of the droplet surface temperature (T_s). Hence, for an approximate estimation, a separate experiment of radiative heating of acoustically levitated droplet is carried out.

High Speed Imaging and IR thermography of levitated droplets: The variation of droplet surface temperature particularly the wet bulb limit is quantified by radiative heating of acoustically levitated droplets in a separate set of experiments. Single axis ultrasonic levitator (Tec5 levitator, 100 kHz frequency, 154 dB) is employed to acoustically levitate EW droplets. Droplets are radiatively heated at different rates ($1-9\ Watt$) using a tunable continuous wave CO_2 laser (Synrad 48, beam diameter of 3.5 mm and wavelength of 10.1 μm). Droplet deformation dynamics is captured using a high-speed camera (Photron FASTCAM SA5) at 7500 fps (temporal resolution of 0.133 ms and pixel resolution of 1024X1000). Simultaneously, droplet surface temperature is monitored using an IR camera (FLIR SC5200) at 500 fps. Further details of this set-up are provided in **[1] [2]**.

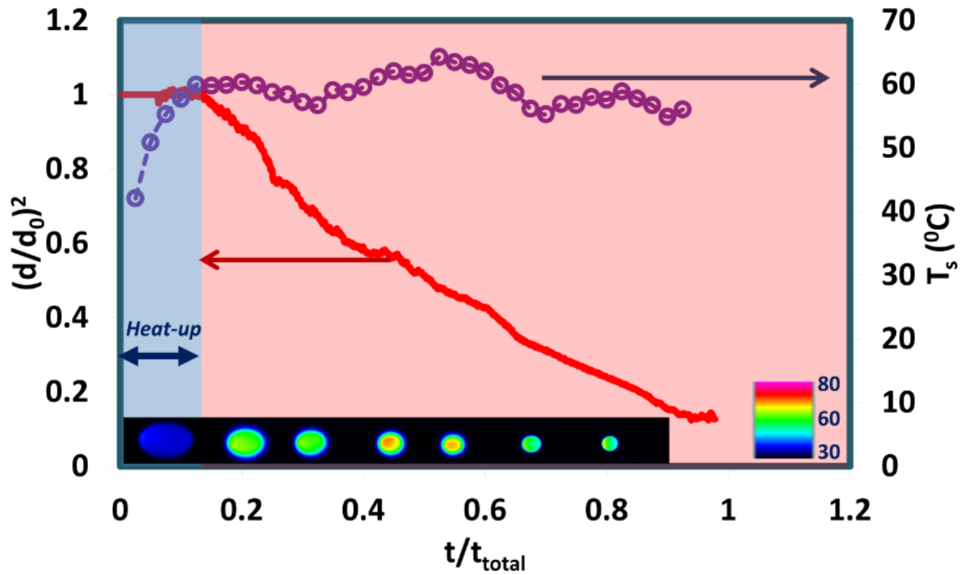

Figure S3. Temporal variation of droplet diameter and average surface temperature (T_s)for levitated EW droplet irradiated with CO_2 laser. After the initial heat-up period droplet surface assumes a nearly constant average temperature termed as wet-bulb limit. Colour bar represents temperature scale.

Effective power (P) required for EW droplet combustion can be given as

$$P = \frac{m}{t_{total}}\left[h_{fg} + C_p(T_b - T_i)\right] \tag{1}$$

For droplet diameter $\sim 1\ mm$, $P \sim 1.5\ Watt$ (effective power) is required for complete combustion. Hence, in the levitation study, laser heating rates between $1-3\ Watt$ are used for maintaining similar heat transfer as that of the present combustion studies. It should be noted that the droplet surface temperature does not show any significant variation $\sim(10-15^0C)$ even at higher heating rates $\sim(5-9)\ Watt$. **Figure S3** illustrates the temporal evolution of the EW droplet diameter and T_s during total evaporation lifecycle. As expected, after an initial heating period (sensible heating), all input heat is utilised for vaporisation with no further temperature rise. Temperature attained after initial heat-up time is termed as wet-bulb temperature. It should be noted that the droplet wet bulb temperature is independent of the mode of evaporation (radiative versus flame induced). EW droplet (marked in **Figure S3**) attains a wet bulb temperature $T_s \sim 58^0 C$. This value of droplet surface temperature is utilised for further calculations associated with combustion studies.

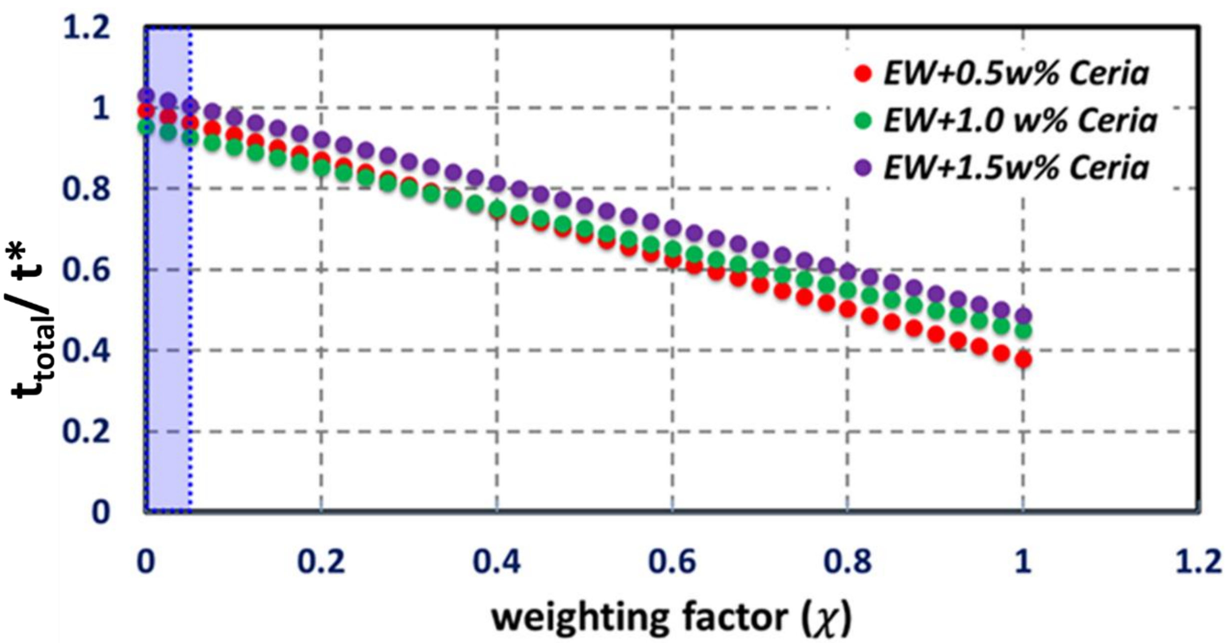

Figure S4. Variation of the ratio of experimental time scale and t^* with weighting factor. Data within the box represents spectrum of χ for the current work. An average value of χ over this range is utilised for calculating t^*.

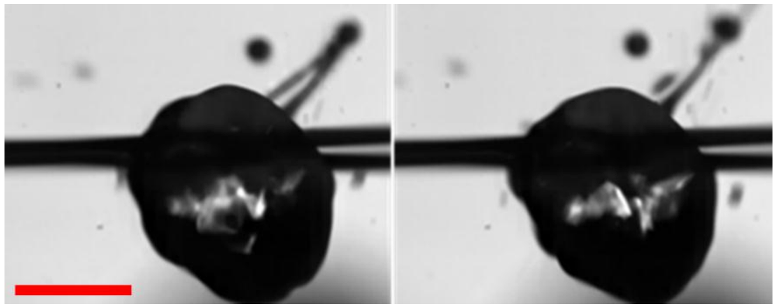

Figure S5. Disintegration of ethanol-water droplet away from the wire (Scale bar is 0.5mm)

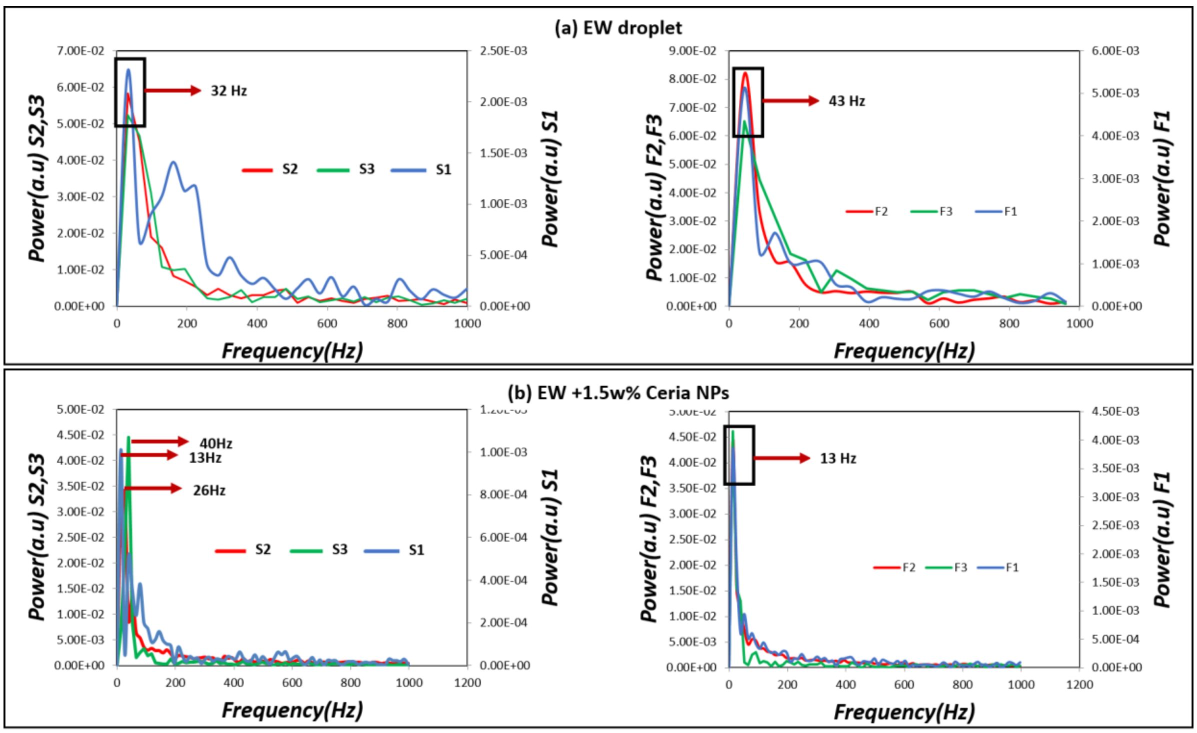

Figure S6. The frequency of oscillation of the principal modes of the droplet shape (S) and flame (F) for (a) Pure ethanol-water droplet, and (b) PLR $w = 1.5\%$. at $t = 0.2t_{total}$.

References

[1] K. Pandey, K. Chattopadhyay, S. Basu, Combustion dynamics of low vapour pressure nanofuel droplets, Phys. FLUIDS. 29 (2017) 074102.

[2] B. Pathak, S. Basu, Deformation pathways and breakup modes in acoustically levitated bicomponent droplets under external heating, Phys. Rev. E. 93 (2016) 033103.

[3] B. Pathak, A. Sanyal, S. Basu, Experimental study of shape transition in an acoustically levitated and externally heated droplet, J. Heat Transf. 137 (2015) 121006.