Drop formation of carbon nanotube suspensions for inkjet printing

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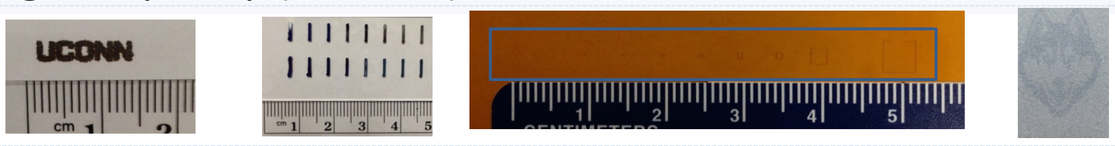
1. Motivation

Inkjet printing:

- Applications: flexible electronics, displays, sensors, wearable electronics, biomaterials, 3-dimensional objects, etc.
- Variety of "inks": metal or carbon particle dispersions, polymer solutions, cell suspensions, etc.

Challenges of jetting particle dispersions:

- Non-Newtonian behavior
- High shear rate (>10^4 s^{-1}), short residence time (5 – 250 µs), high frequency (> 20 kHz)



2. Objective and Approach

Objective:

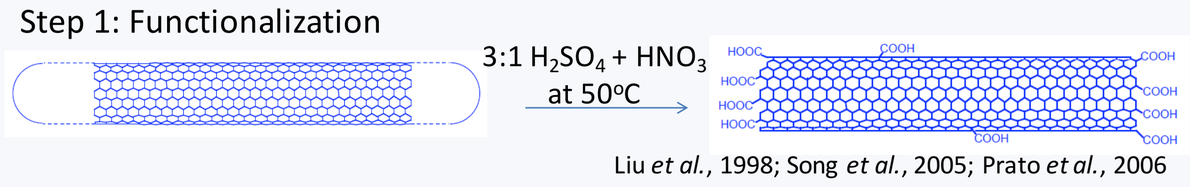
To investigate how the inclusion of carbon nanotubes (CNTs) influences the jetting behavior and drop dynamics.

Approach:

A large-drop generator with a stroboscopic imaging system was custom-built to characterize the drop formation

Preparation of "CNT ink":

Step 1: Functionalization



Liu *et al.*, 1998; Song *et al.*, 2005; Prato *et al.*, 2006

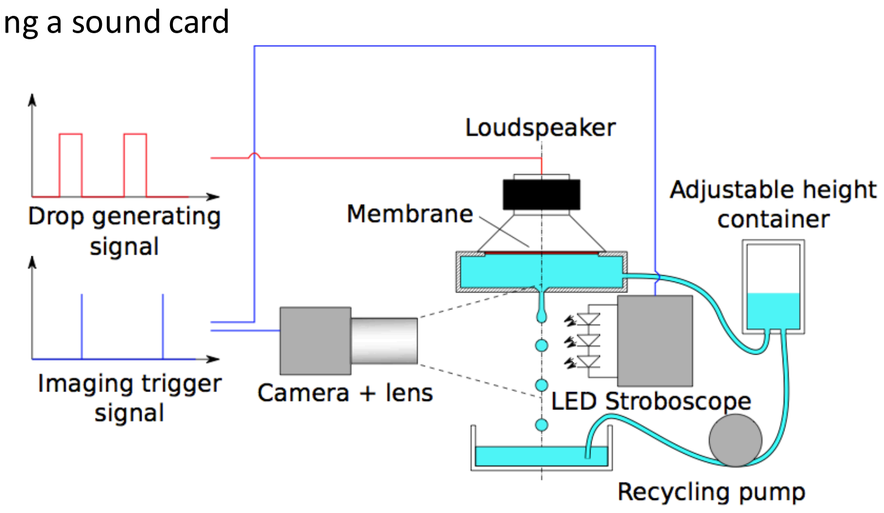
Step 2: Disperse in water/glycerol mixture using sonication

3. Stroboscopic Imaging of Drop Formation

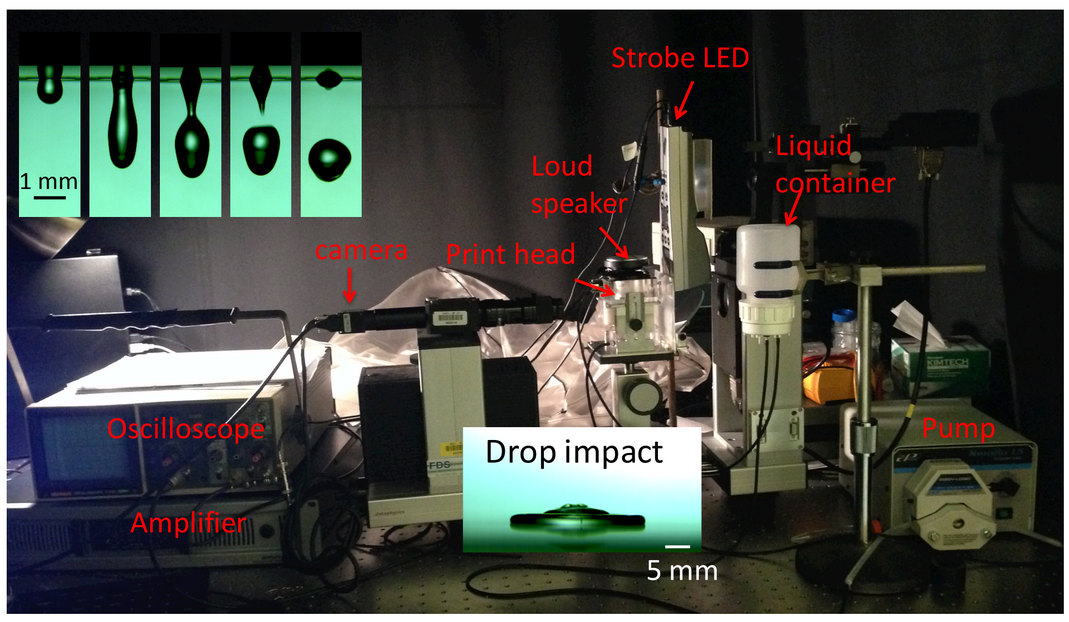
System Design

Stroboscopic imaging:

- Flash illumination
- Camera, drop generating signal and illumination are synchronized using a sound card

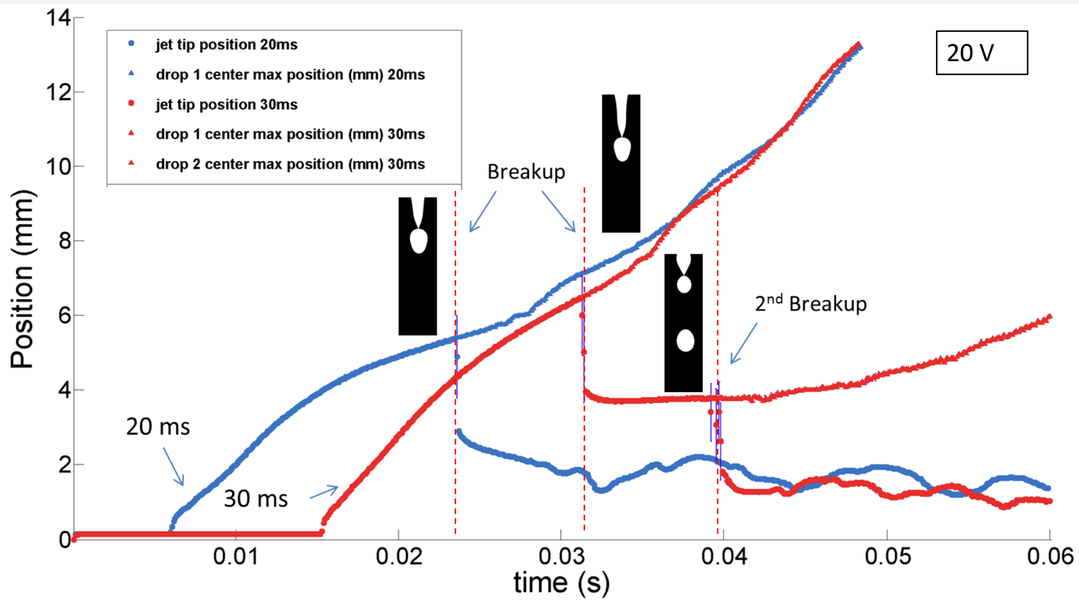


Experimental Setup

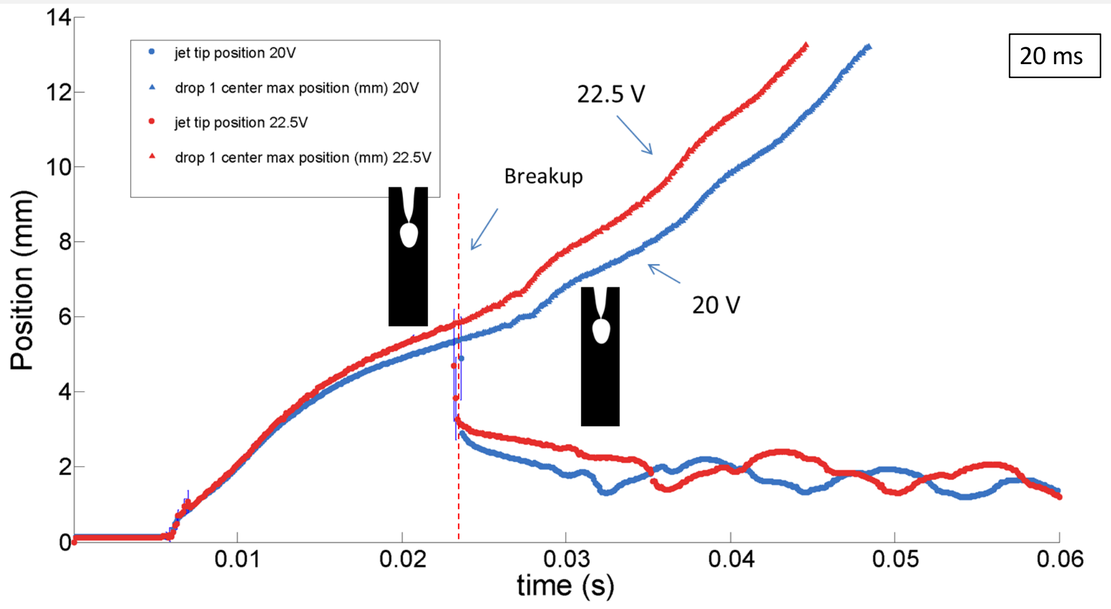


4. Drop Formation of CNT Suspensions

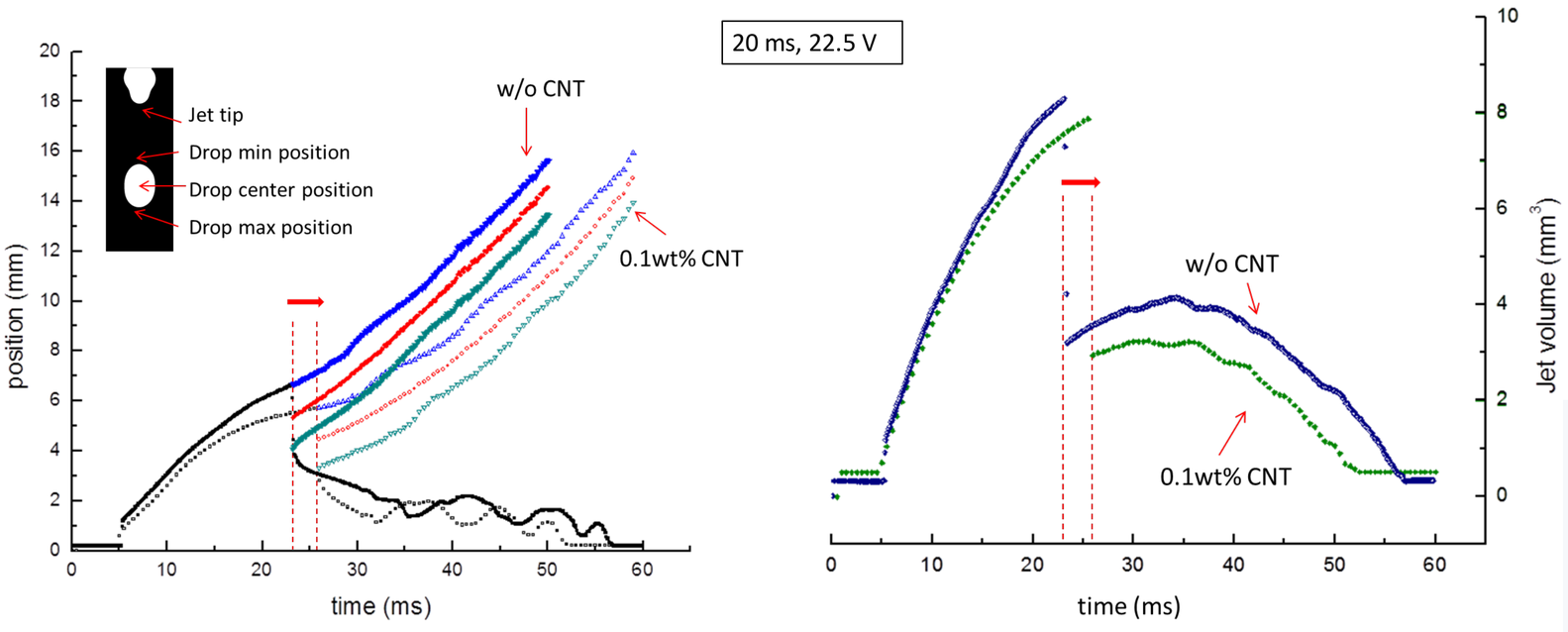
4.1 Actuation Signal Width

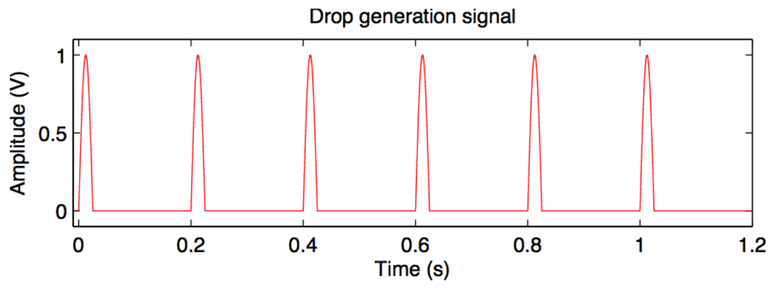


4.2 Actuation Signal Voltage



4.3 Inclusion of CNTs





Drop generation signal: sinusoidal signal with a pulse width and voltage indicated in the figure. Ten images were taken at the same delay time every 0.1 ms for glycerol/water mixture and every 0.5 ms for CNT suspensions.

*w/o CNT: 20% glycerol in water solution, with CNTs: 0.1wt% functionalized CNTs are dispersed in 20% glycerol in water solution.

5. Preliminary Findings

- A large-drop generator with an stroboscopic imaging platform was custom-built to study drop dynamics
- Larger signal width delays drop breakup and potentially induces secondary breakup
- The inclusion of CNTs delays the drop breakup