Combing of Genomic DNA from Droplets Containing Picograms of Material

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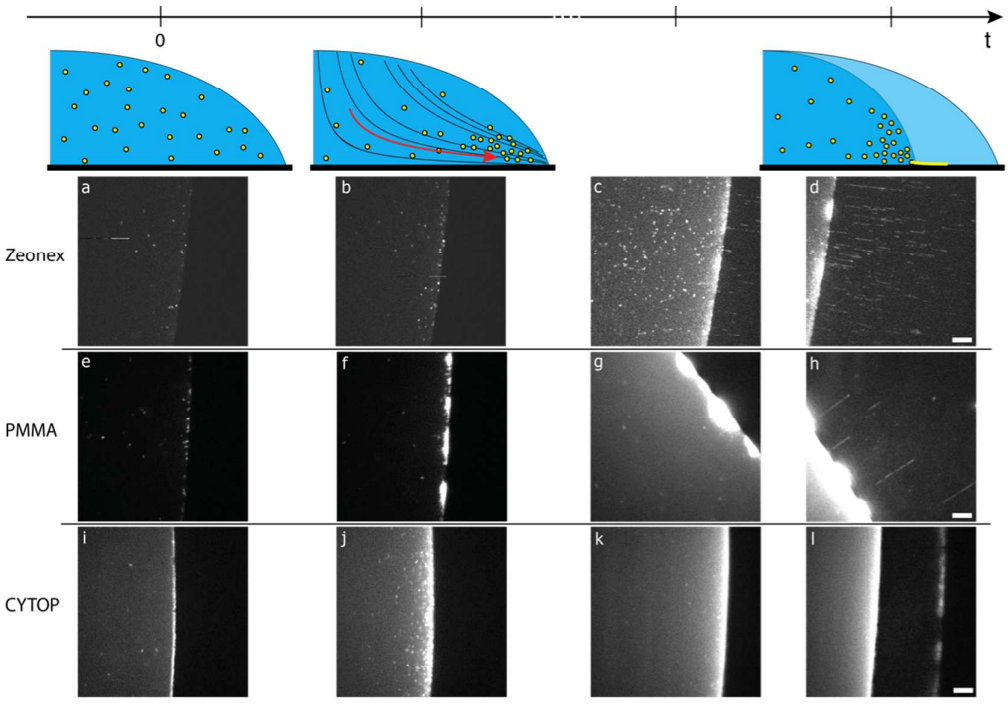
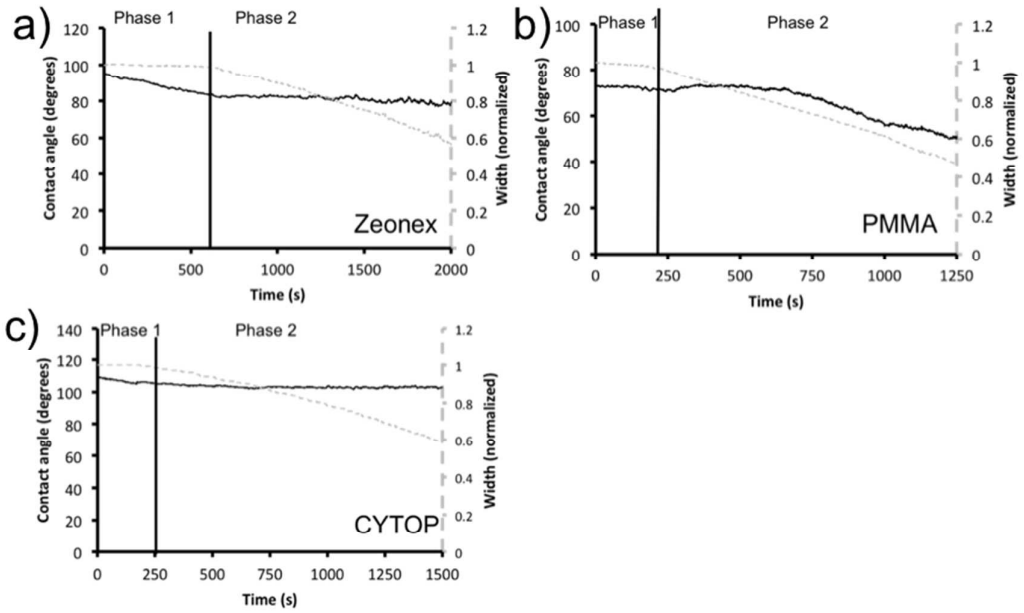
Supplementary Figure 1: Mechanism of DNA deposition from droplets on different surfaces.



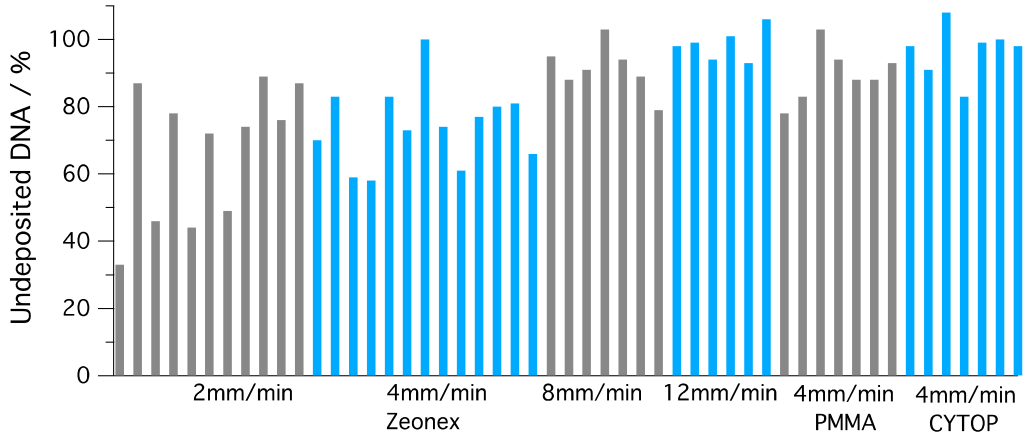
(Top) Schematic of the droplet showing DNA molecules (yellow) drawn towards the edge of the droplet due to the capillary flow (black lines) induced by the coffee ring effect. The retracting meniscus deposits DNA on the surface. The images in the three rows depict the different stages in droplet evaporation on three different surfaces. (a - d) DNA deposition on Zeonex. A slight increase in concentration of DNA at the contact line is noticeable during phase 1 of the evaporation (a and b). However, the majority of the DNA attaches to the surface during phase 2 of the evaporation (c) and is subsequently combed as the meniscus passes over it (d). On the PMMA surface (e-h), there is an increase in concentration at the contact line during phase 1 of the evaporation (f), during phase 2 the DNA steadily accumulates at the contact line (g) and some of this is combed as the meniscus retracts (h). On the CYTOP surface (i-l) there is an increase in concentration at the contact line (j) in phase 1 but no DNA is deposited during the retraction of the meniscus (l). The length of the white scale bars are 10 μm.

Supplementary Figure 2: Droplet evaporation on three hydrophobic polymer substrates.



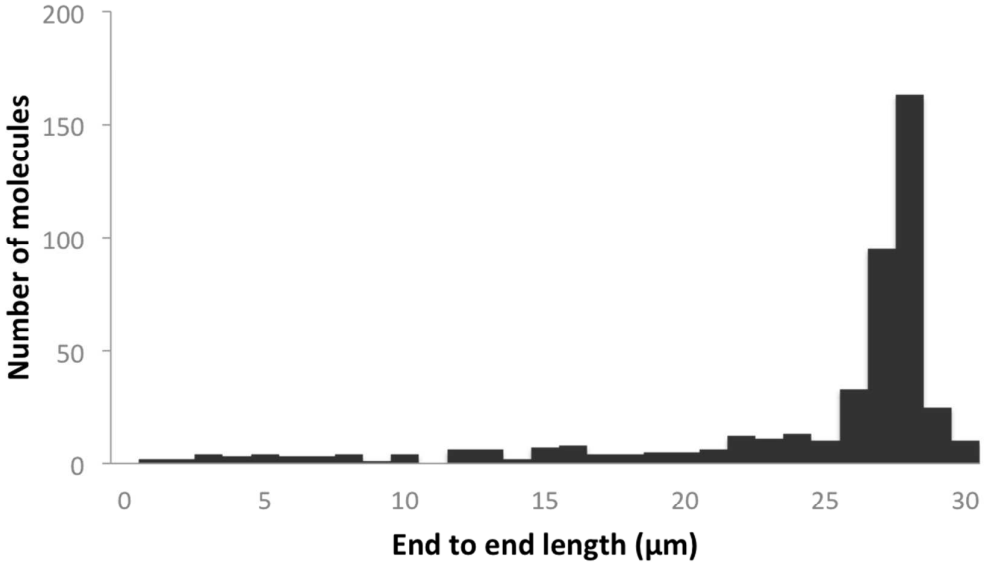
Plots showing the change in droplet contact angle (solid line) and the corresponding width of the droplet (dashed line) as the droplets are allowed to evaporate on (a) Zeonex, (b) PMMA and (c) CYTOP. For all three surfaces two distinct phases can be distinguished in the evaporation process. In the first phase of the evaporation, the droplet is pinned at the contact line. This means that as the water evaporates the contact angle decreases, while the width of the droplet remains constant. In the second phase of evaporation the width of the droplet decreases approximately linearly over time. Towards the end of the second phase, as the relative concentration of the salts in the buffer increases, the droplet will eventually pin again while the contact angle drops dramatically (not shown).

Supplementary Figure 3: DNA deposition efficiency as a function of surface and droplet travel speed.



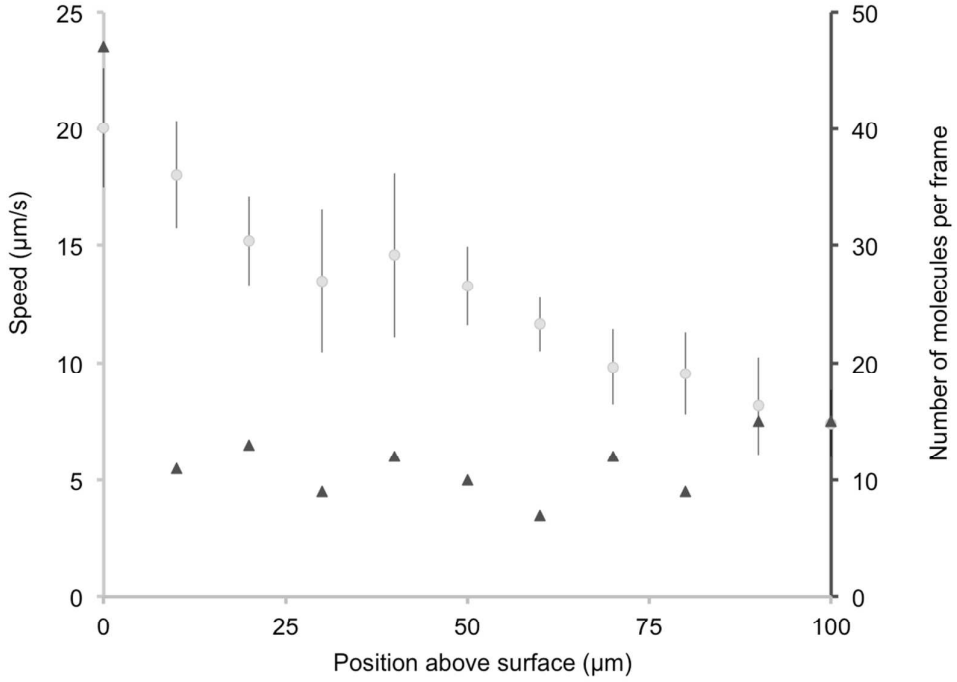
Plot showing the amount of DNA that remains in a series of 2 µL droplets which have been translated over 5 cm of a functionalized surface at the denoted speed. Each bar shows the result from a single measurement. The sensitivity (reproducibility) of the measurement limits the conclusions that can be drawn but a trend towards significantly more DNA deposition is observed with decreasing translation speed on Zeonex.

Supplementary Figure 4: Length distribution of phage lambda genomic DNA deposited on Zeonex coverslips using the rolling droplet method.



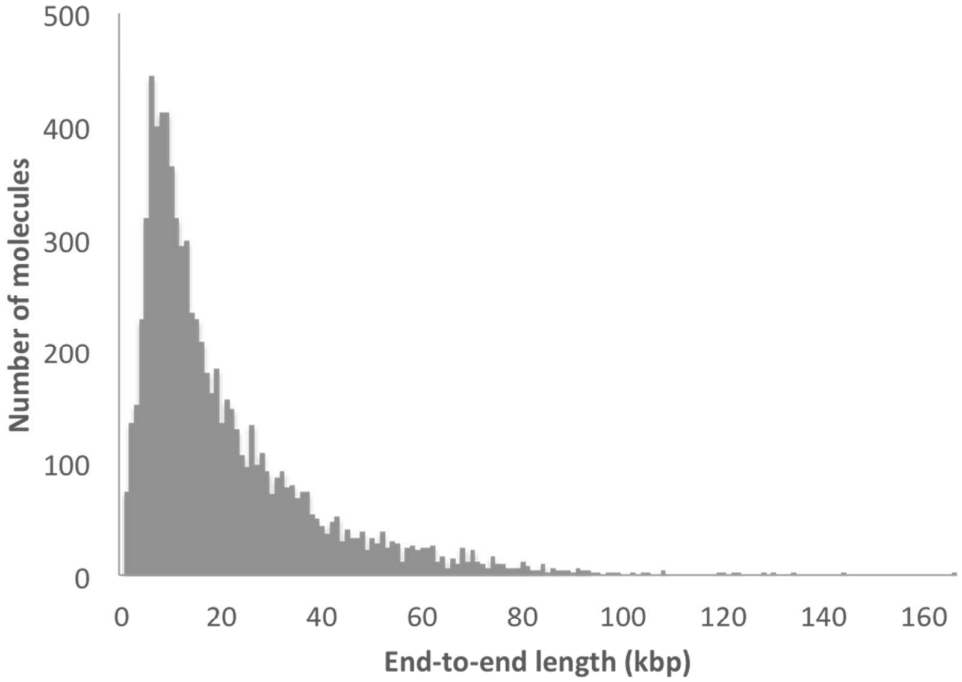
Plot showing length distribution of stretched phage lambda DNA (48 502 bp) on a Zeonex coverslip using the rolling droplet method. Sizes below 25 µm most likely correspond to randomly cleaved DNA due to pipetting. Excluding these, the average size corresponds to 27.6 (±1) µm, which is 1.67 (±0.06) times longer than the solution-phase contour length of phage lambda DNA. The DNA is deposited from a 2 µl droplet containing 200 pg/µl DNA and 250 nM YOYO-1 moved at a speed of 4 mm/min on a Zeonex coated coverslip.

Supplementary Figure 5: Speed of the flow in the droplet and number of molecules as a function of depth into the droplet from the Zeonex.



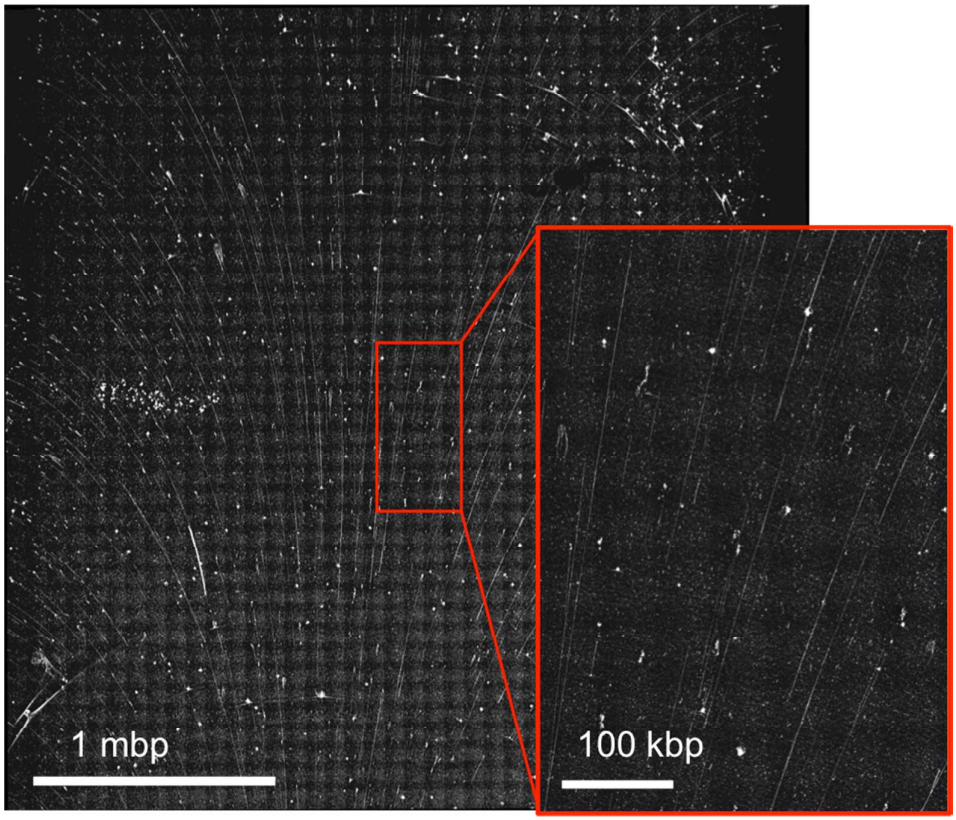
Plot showing the number of particles observed at each position above the surface (triangles) and observed speed of each particle in confocal measurements when dragging a droplet with 1.5 mm/min or 25 µm/s (round markers). There are approximately five times more particles at the liquid-solid interface compared to the bulk of the droplet's solution. The speed at the surface drops according to our model.

Supplementary Figure 6: Length distribution of stretched human DNA on a Zeonex coverslip using the rolling droplet method.



Histogram of size distribution of DNA molecules assuming a stretching factor of 1.67 (Supplementary Figure 3) based on Figure 4 (see manuscript text). The many smaller DNA molecules are most likely caused by random shearing of DNA due to handling of the sample (cell lysis, pipetting and purification of the sample).

Supplementary Figure 7: Deposition of human genomic DNA from a droplet containing 200 pg of material.



Composite image assembled from 1600 wide field images showing stretched human DNA on a Zeonex surface. In order to have predictable, uniform deposition of DNA over such a large area we simply pulled a droplet across the substrate surface. As a result of the ability of Zeonex to transiently trap DNA, we are able to create surfaces covered with many gigabases of DNA molecules with a controllable deposition density. In this instance the droplet is a 2 µL droplet containing 400 pg of DNA and was translated across the surface at 2 mm/min. Note that 100 kilobase pairs (kbp) is equal to 57 µm.