Concentration Polarization and Electroconvection in a Nanoslot Array of Varying Interchannel Spacing

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Supplementary Material Information:

Chip fabrication

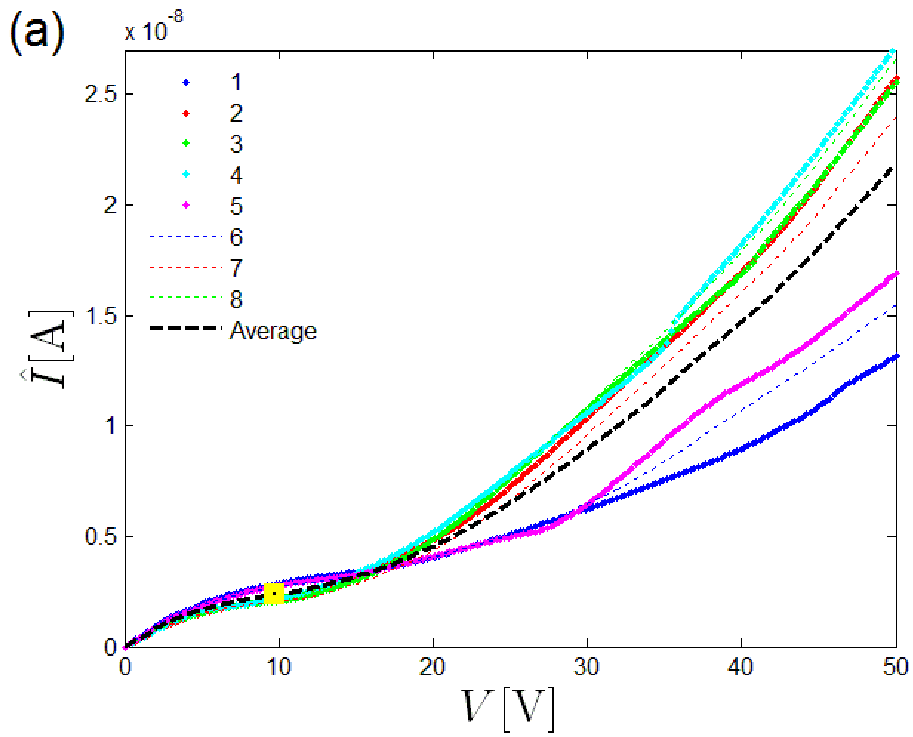
The fabrication technique closely follows that used in our previous work [18]. Briefly, the micro-chambers were wet-etched into a 1 mm thick Pyrex glass slide where inlet/outlet access holes were mechanically drilled into each of them. The nanoslot array was dry-etched (RIE) into the deposited sacrificial polysilicon layer on top of a second 1 *mm* Pyrex glass slide. The anodic bonding of both slides formed an array of nanoslots that connects the two micro-chambers.

Chip setup and cleaning procedure

The experimental setup and cleaning procedures also closely follow those used in Green & Yossifon [18]. Briefly, reservoirs made of flexible silicone (Grace Bio-Labs) were used on top of the drilled holes inlets wherein platinum wire electrodes are inserted. The electrodes are connected to an electrical voltage source and I-V converter (Keithley 2636). The channels were cleaned of ionic contaminants by applying a voltage difference of approximately 10-20 V with periodic flushing of the reservoirs with fresh DI water until the current equilibrated to a minimum, which typically took an hour. After which the KCl solution was introduced into the system.

Determination of the limiting current

For each chip configuration several repetitions of the I-V measurement were performed. All individual measurements were averaged to give the mean current depicted in Fig. 2. In Fig.S1a we show the measurements for Array F and the resultant mean (dashed black line). In addition to calculating the mean current, we also calculated the differential conductance, $d\hat{I}/dV$ for each measurement and its mean. The limiting current (used in Fig. 3) selected was the point of the minimal differential conductance of the mean (marked by a yellow square



(b)

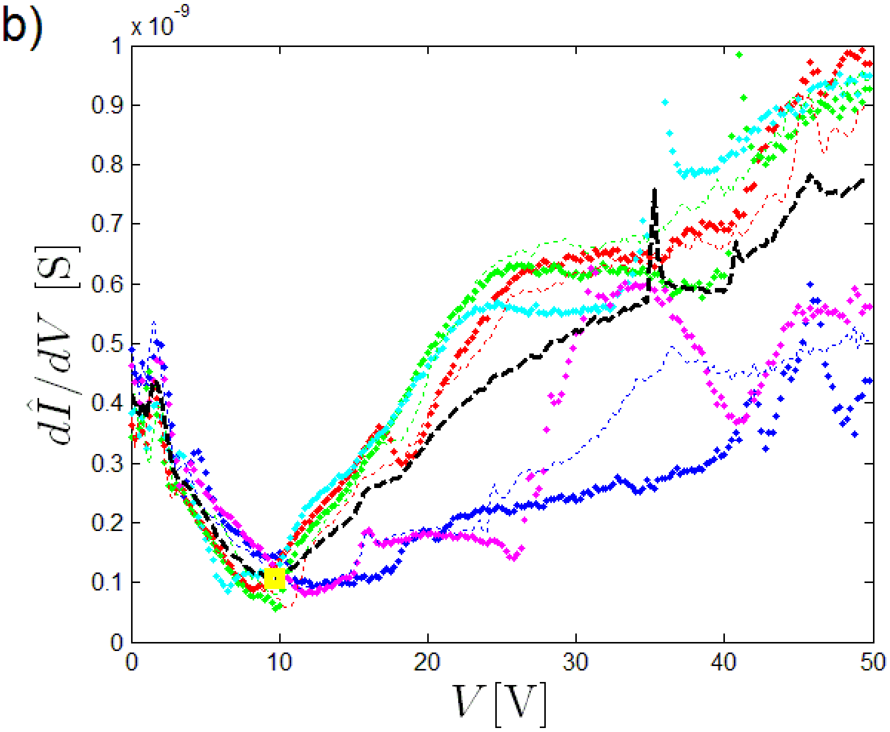


FIG. S1. (Color online) (a) Individual I-V's per channel and (b) differential conductance per channel for Array F. The dashed black line marks the calculated mean while the large yellow square marks the point of the minimal average differential conductance and corresponding limiting current.

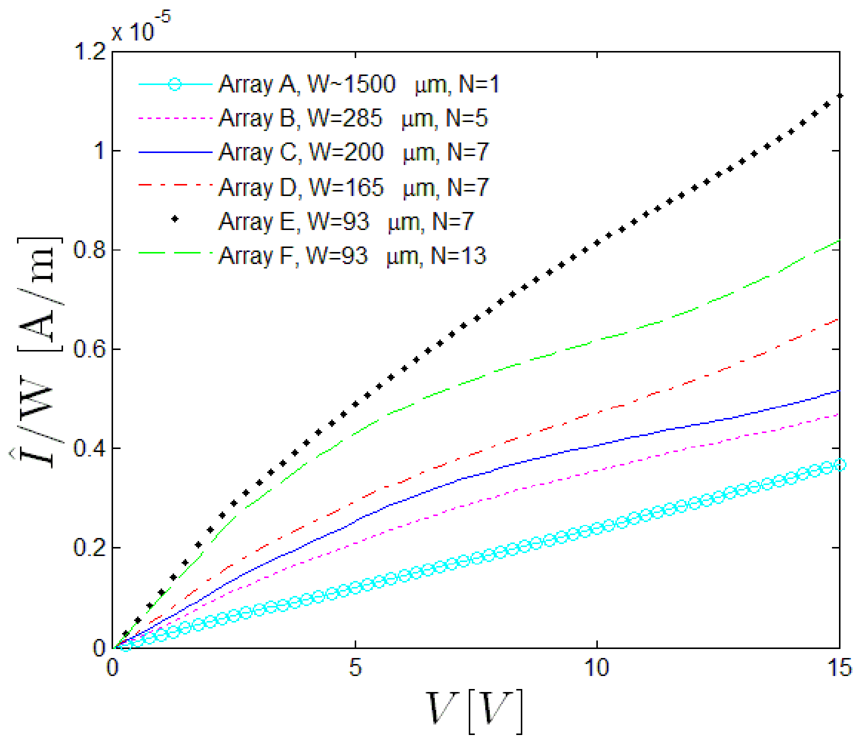


FIG S2. (Color online) The current density per channel , $\hat{I}/W$, for the various arrays. The predicted reversal [21,22] of the current density (per channel) compared to that of the current (per channel) behavior is confirmed.

CP and colloid dynamics visualization

For visualization of CP, positively charged Rhodamine 6G dye molecules at a concentration of approximately $\sim 20\mu M$ were added to an electrolyte with a KCl concentration of 30 μM. To visualize the inner flow structure of the CP as well as the dynamics of the stagnation points, negatively charged fluorescent 1 micron polymer microbeads of a volumetric concentration of ~0.01 % were used.

Movies

1. Movie 1 – describing CP and colloid dynamics under an applied voltage of 45 V for Array A (single channel), Array B, and Array F.
2. Movie 2 – describing CP and colloid dynamics of Array B (largest interchannel spacing) for an applied voltages of 10V, 30V and 45 V.
3. Movie 3 – describing CP and colloid dynamics of Array F (smallest interchannel spacing) for an applied voltages of 10V, 30V and 45 V.