Supplementary Material

Retention of Silica Nanoparticles on Calcite

Carbonate Sands Immersed in Electrolyte Solutions

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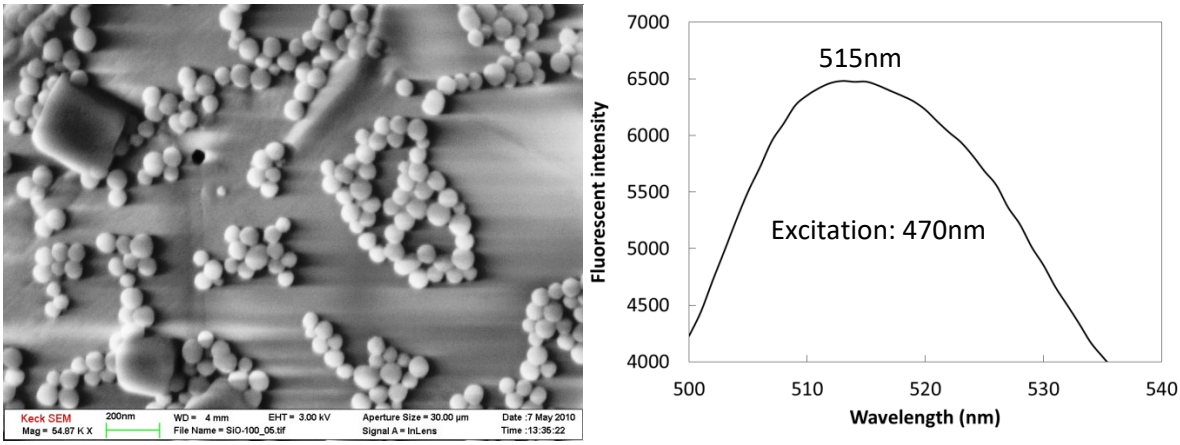


Figure S1. (Left) A SEM image of green fluorescent SiO_2 nanoparticles. The particle diameter is 87±12nm. (Right) The fluorescent spectrum of SiO_2 nanoparticles when the nanoparticles are excited at 470 nm.

Text S1: Electrolyte solutions:

Analytical grade NaCl (Sigma-Aldrich) and Na_2SO_4 (anhydrous, granular, Mallinckrodt Chemicals) were used without further purification. Millipore "Milli-Q" water with a conductivity of less than 1.8×10^{-6} S cm-1 at 20˚C was used in all experiments. A series of NaCl and Na_2SO_4 solutions were prepared within an hour of performing the atomic force microscopy measurements. Solution concentration varied from 0.5mM to 100mM. The PH of these electrolyte solutions was between 9 and 10.

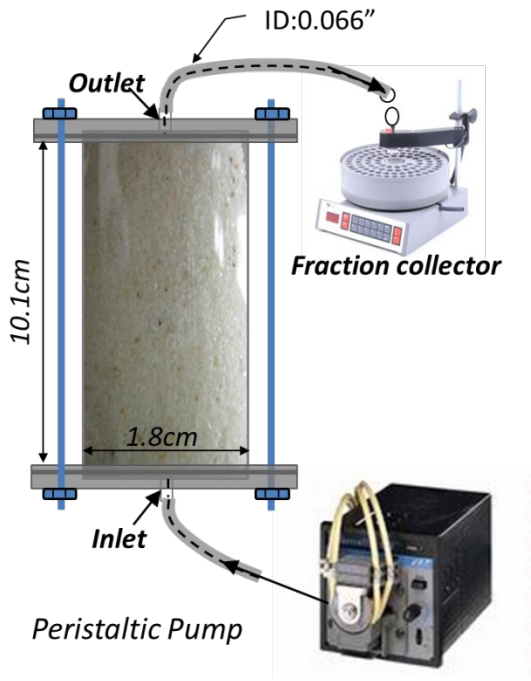
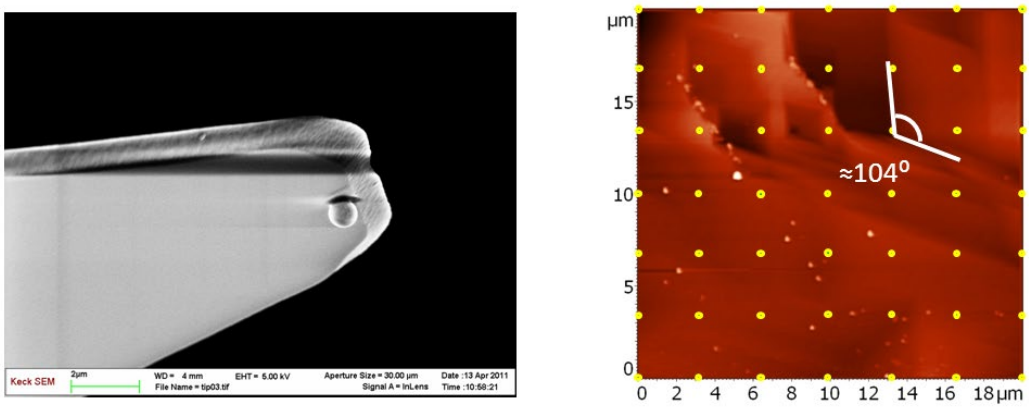


Figure S2. Scheme of the experimental apparatus.

Text S2: Screening Column Design

The inner diameter of the column was 1.8 cm, the height of the sand pack 10.1 cm. About 50 g of calcium carbonate sand was loaded into the column under wet conditions: The column is partially filled with deionized water and then the calcium carbonate sand is gradually added. Deionized water is needed so that the calcium carbonate sand is always introduced through a layer of water, which assures that no air is present in the water-saturated sand pack. The caps are attached snugly on the ends of the column using the four screws. The porosity of the sand is 55%. The pore volume of the sand pack is 14.34 ml.



(a) (b)

Figure S3. (a): a SEM image of a silica colloidal AFM probe. (b): the 36 points on a 20µm x 20µm area of a calcium carbonate crystal, where force measurements were performed for all the solution studied.

Text S3: AFM Force Curve Conversion

The force curves were obtained in the voltage versus displacement mode of AFM operation. The raw data was converted to a force-distance curve using the commercial software provided by NOVA and the manufacturer-indicated cantilever force constant of 0.35N/m. In order to interpret the force-distance curves it is necessary to set the zero force and the zero separation from the surface on the AFM. We chose the zero of force as the measured force when the tip was well off the surface and neither positively nor negatively deflected. We chose the zero of separation distance to be where the slope of the force-distance curve becomes abruptly greater, which presumably occurs as the tip "hits" the surface".

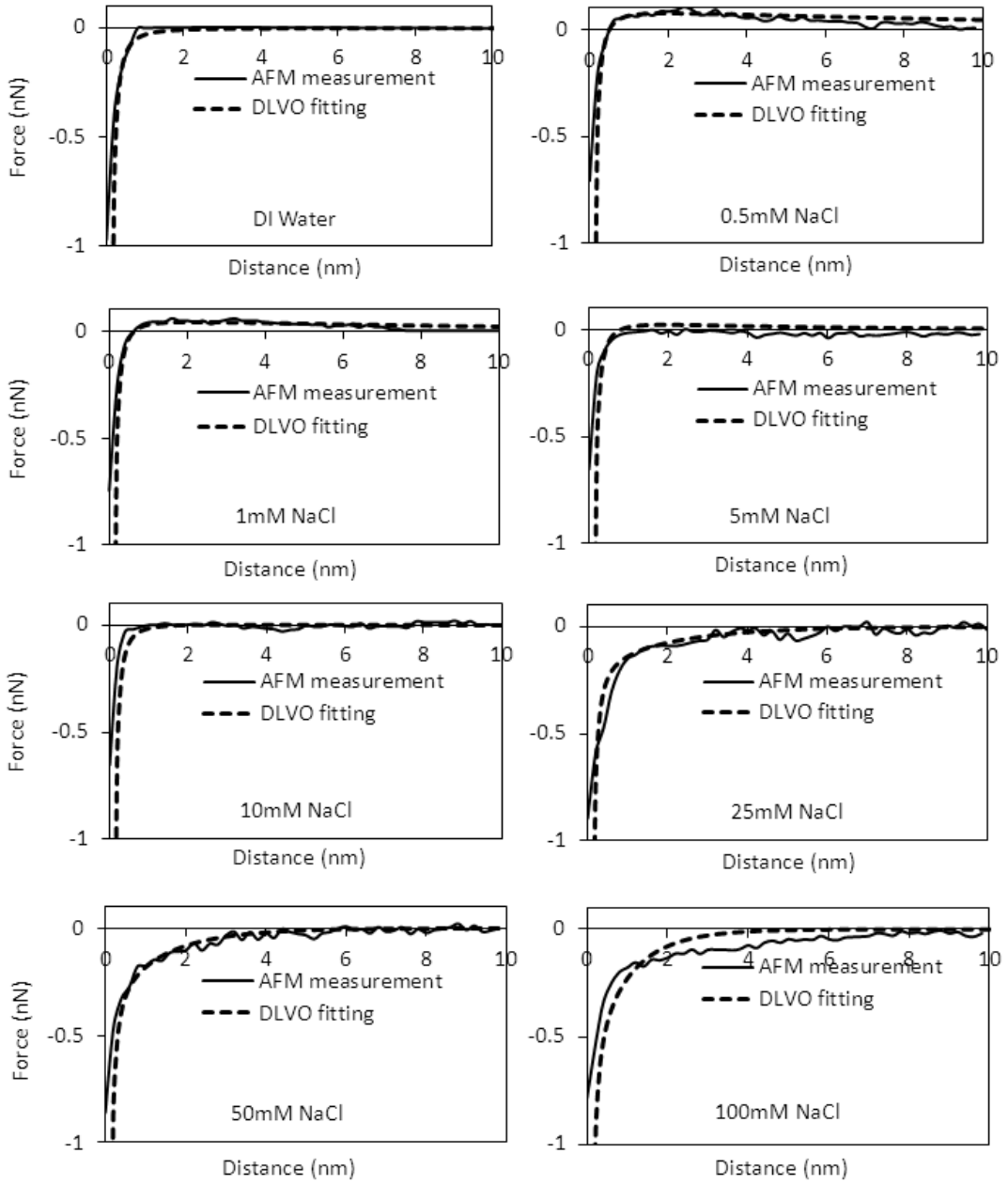


Figure S4. Force profiles predicted by DLVO model (dashed curves) for the DI water and the NaCl solutions with concentration varying from 0.5mM to 100 mM are compared to the force curves measured by the AFM (solid curves).

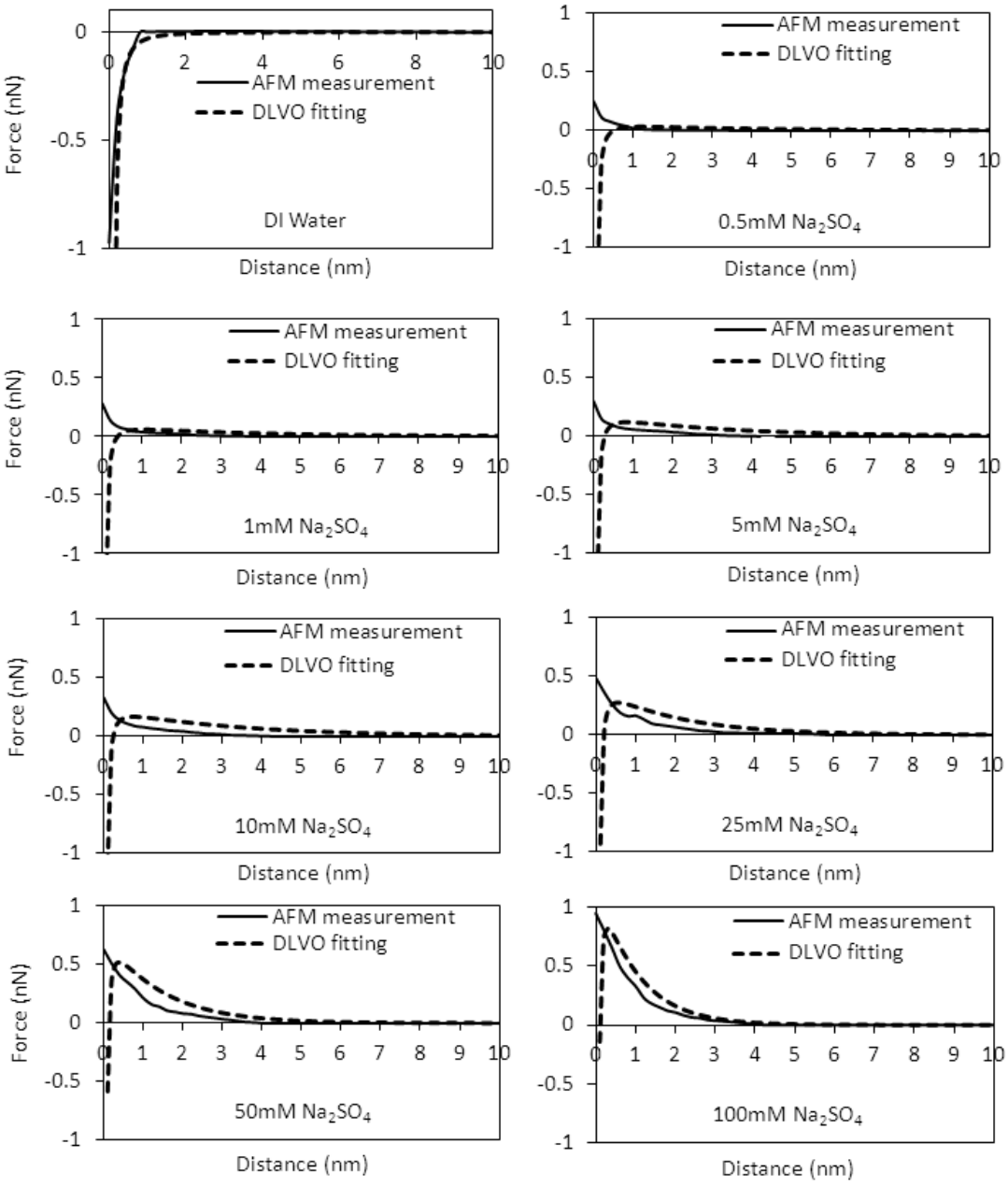


Figure S5. Force profiles predicted by DLVO models (dashed curves) for the DI water and the Na_2SO_4 solutions with concentration ranging from 0.5 mM to 100 mM are compared to the force curves measured by the AFM (solid curves).