Quartz Cylinder Fabrication for Torque Measurement in the Single-Molecule Level

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Primary CNF Tools Used: ASML Deep Ultraviolet Stepper, Oxford 81 Etcher, Oxford 82 Etcher, Oxford PECVD, SC4500 Odd-Hour Evaporator, SC4500 Even-Hour Evaporator, Zeiss Supra SEM, Zeiss Ultra SEM

Abstract:

To facilitate single-molecule torque measurements with the angular optical tweezer (AOT), we designed and fabricated quartz cylinders that can specifically attach DNA molecules to achieve a true angular trap. These cylinders have been widely used to investigate single-molecule torsional properties and they are currently uses in multiple research projects.

Summary of Research:

Torsional stress plays an important role in fundamental biological processes such as transcription and replication. During these processes, torsion can accumulate both upstream and downstream of the transcription complex or the replisome. We are specifically interested in how the DNA responds to these topological changes. To quantitatively investigate this, our lab developed a tool, the angular optical trap (AOT), to measure torque at the single-molecule level [1-3]. In our approach, a linearly polarized light is used to trap and rotate a birefringent particle anchored with a torsionally constrained DNA molecule for manipulations and measurements [1]. To achieve a true angular trap, we designed the birefringent particle to have a cylindrical geometry (with an aspect-ratio ~ 2) [2, 3] (Figure 1). In this way, the cylindrical axis tends to align to the laser propagation direction, which ensures the extraordinary axis is always perpendicular to the laser propagation direction even when attached to a biomolecule. The cylinder top surface is specifically functionalized with (3-Aminopropyl)triethoxysilane to be covalently coupled with protein for DNA molecule anchoring. These quartz cylinders have been broadly used in the single-molecule torsional mechanics study in our lab [3-8].

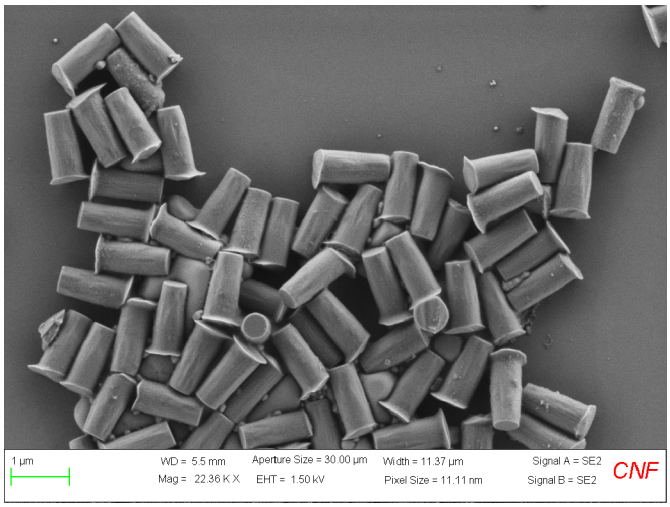

Figure 1: An SEM image of the cleaved quartz cylinders.

Conclusions and Future Steps:

We are now applying the quartz cylinders to extend our previous work on the torsional stiffness of the braided DNA molecules [6].

References:

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