Supporting Information

Nanofibrous Adhesion: the Twin of Gecko Adhesion

by Guangming Gong, Chen Zhou, Juntao Wu[*], Xu Jin, Lei Jiang

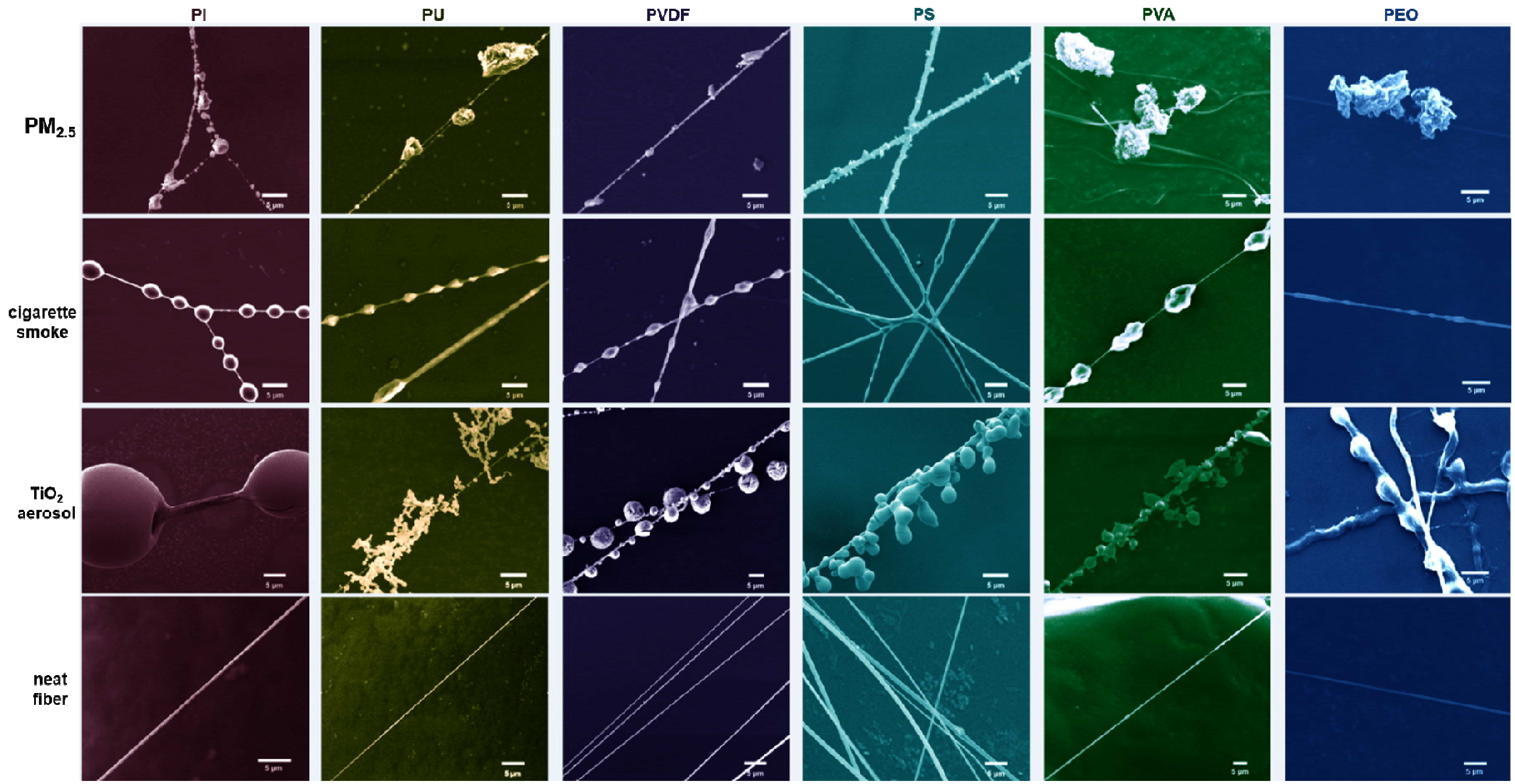

Figure S1. Multiple kinds of particulate substances captured on the surfaces of different types of polymeric nanofibers. The morphologies of nanofibers before and after this procedure were characterized by SEM and were illustrated. The abilities of particle-capture of multiple nanofibers, including polyimide (PI), polyurethane (PU), polyvinylidene fluoride (PVDF), polystyrene (PS), polyvinyl alcohol (PVA), polyethylene oxide (PEO) were examined. The particulate matters included $PM_{2.5}$ from the polluted air, cigarette smoke, TiO_2 aerosol produced from $TiCl_4$. It proved that the nanofibrous adhesion to particulate matters would eventually happen no matter what the nanofibers or the particles were.

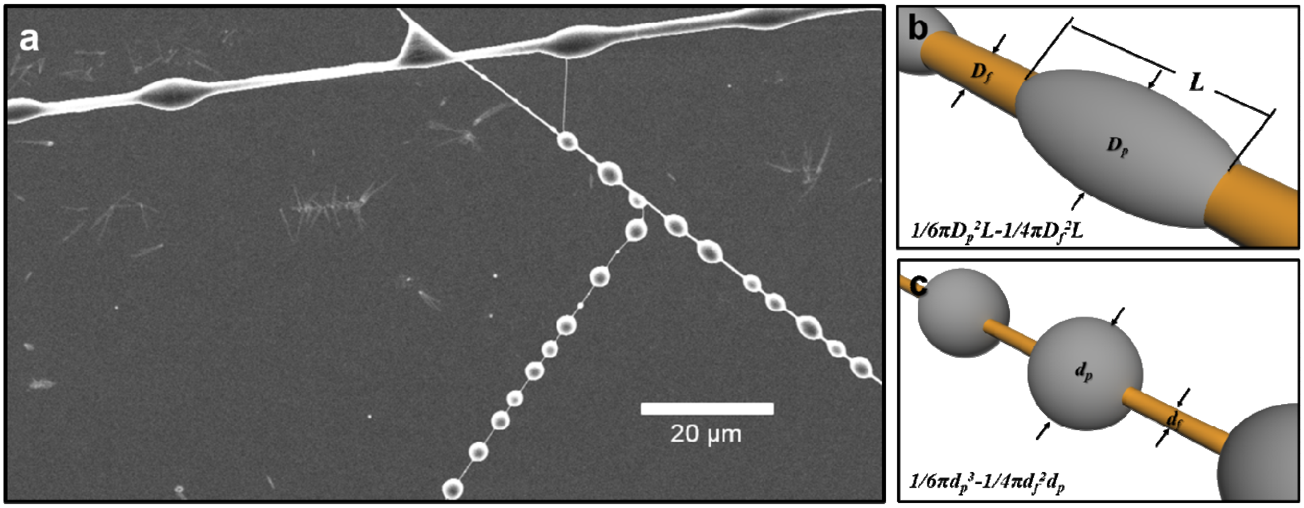

Figure S2. Smoke capturing efficiency of thick and thin nanofibers and the calculation details. Here, to simplify the calculation, we suppose the spherical marbles attached on the thin fiber are perfect balls and the spindle-like beads attached on the thick fiber are ellipsoids with perfect circle profile. Consider the thinner fiber, the volume of smoke marble that it can secure equals to the volume of the ball minus the volume of the cylindrical fiber, which is $1/6\pi d_p^3-1/4\pi d_f^2 d_p$. While to the thick fiber, the volume equals to the volume of the ellipsoid minus the volume of the cylindrical fiber, which is $1/6\pi D_p^2L-1/4\pi D_f^2L$, L is the axial length of the bead. Each divided by the volume of the fiber, the ratios should be $2/3(d_p/d_f)^2-1$ for the thin fiber and $2/3(D_p/D_f)^2-1$ for the thick fiber. According to our observation, since $d_p/d_f >> D_p/D_f$, as a result, thin fiber was much more efficient in securing smoke than the thick fiber.

Measuring the surficial adhesive force by using an Dynamic Contact Angle Detector (DCAD)

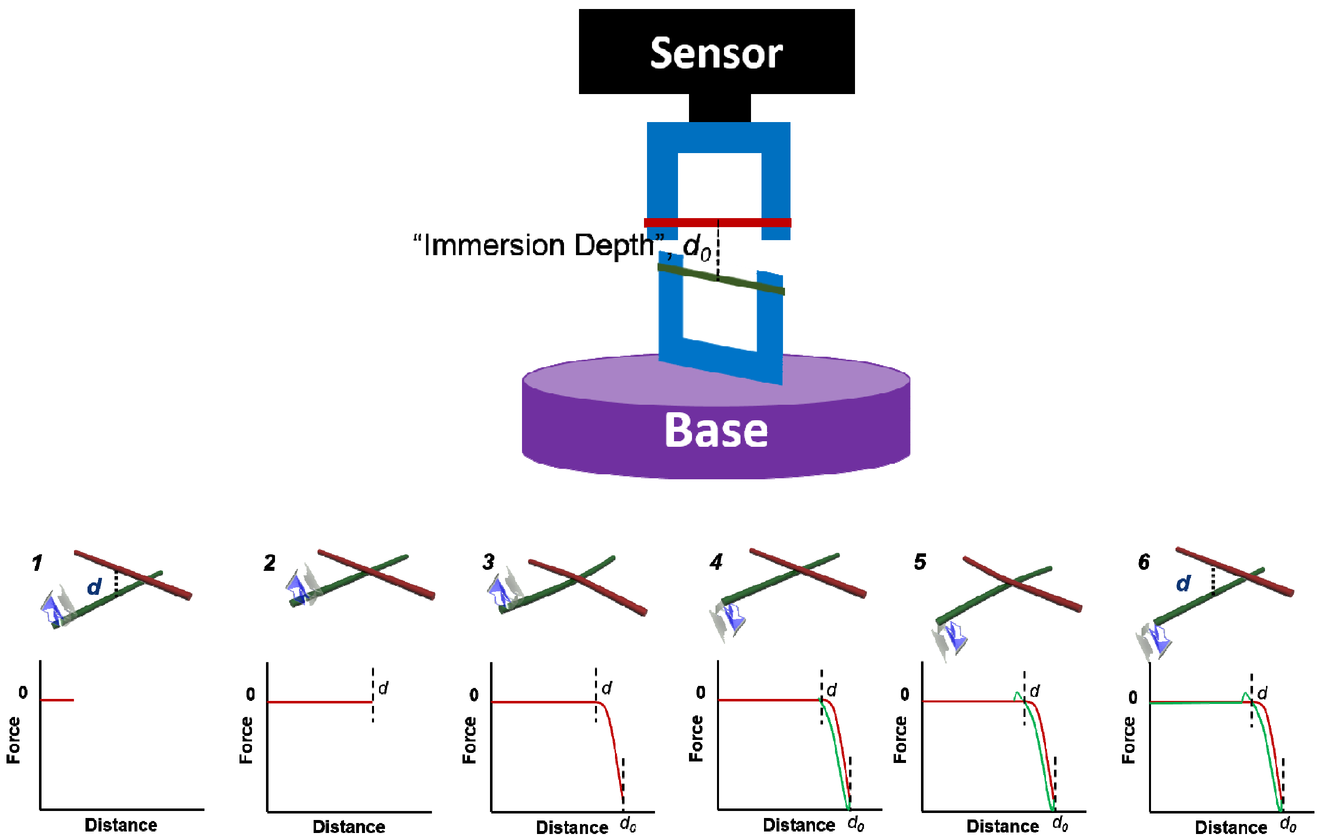

Figure S3. A brief chart of the components of the DCAD and the main steps during the adhesion tests, as well as the typical curves corresponding to the very steps

DCAD (Dataphysics™, Germany) is actully an adapted micro balance. The basic components of the device are briefly illustrated in Figure S1. The sensor's measurable lower limit is 10^{-5}g, which is equal to 0.1μN. The base is driven by a motor which is able to proceed at 10^{-2} mm/s.

Before the adhesion test, two U-shape frames with secured testing fibers were attatched onto the equipment as demonstrated. The angle between two fibers should be about 90 degrees to make sure the contact mode was similar to point-point contact mode. A certain amount of distance between these two fibers was set as *d*. *d* should be smaller than the Immersion Depth d_0, which would be the total distance of the moving base, in order to make sure the contact of these two fibers. Then the test procedure should begin.

The Testing Mechanism:

The test could be devided into two parts: the base rising towards the sensor, called the advancing circle; the base descending to its original position, called the receding circle. 1): At the beginning state of advancing circle, the residual reading of the sensor was cleared. During the lower fiber (in green) moving towards the upper fiber (in red), the sensor detected no force and the curve stayed at 0; 2): when the base movement had covered *d*, the green fiber touched the red fiber, then the sensor detected an upward force and the reading curve started to decend; 3): the base rose continuely and the green fiber pushed the red fiber upward until the base covered its full rising distance d_0, and the advancing circle was ready to end; 4): the base started to descend and the sensor's reading begin to fall, and the reading curve started to rise up till the base's moving distance went back to *d*; 5): due to the existance of adhsion on the surface of thin fibers, the green fiber started to drag down the red fiber, and the sensor sensed an extra force pulling downward, until these two fibers broke apart. The maximun force sensed could be read at the peak of the green curve, the maximun adhesion of the fiber should be the peak minused the base line reading; 6): the detached fiber caused no extra force, the reading stayed at 0 and the base went back to its original position. Then the receding circle was over.

The Results:

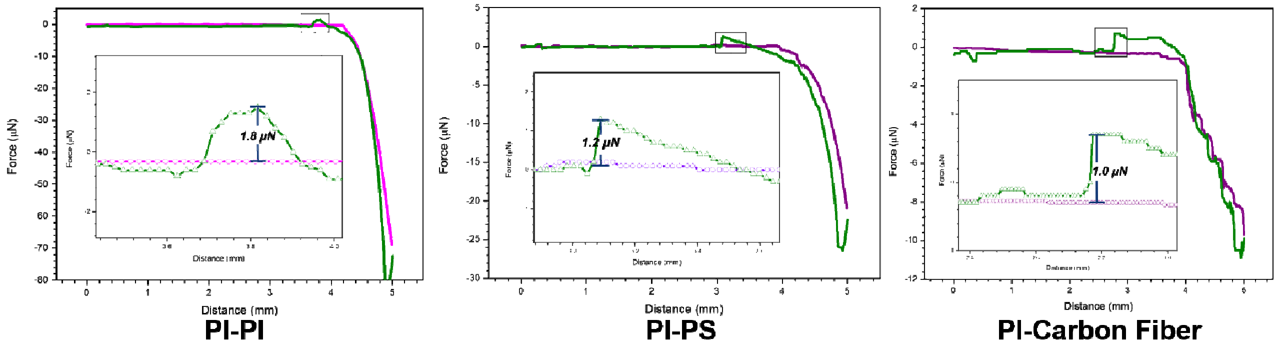

Figure S4. Nanofibrous adhesion between differed types of fibers. The nanofibrous adhesion between PI-PI nanofibers, PI-PS nanofibers and PI-Carbon-fibers were characterized. PI-PI interfacial adhesion was 1.5±0.55 μN, PI-PS interfacial adhesion was 1.3±0.60 μN, PI-Carbon-fiber interfacial adhesion was 1.1±0.17 μN. According to Ref. 16 & 17, which demonstrated that the measured force of gecko-foot hair was in the range of *van der Waals* force, our results agreed with their conclusion. So we drew the conclusion that the surficial adhesion of nanofibers was mainly driven by *van der Waals* force.