SUPPLEMENTARY INFORMATION

Ice sliding on nanoscale-smooth surfaces and the role of the quasi-liquid layer

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EFFECT OF PUSHING SPEED

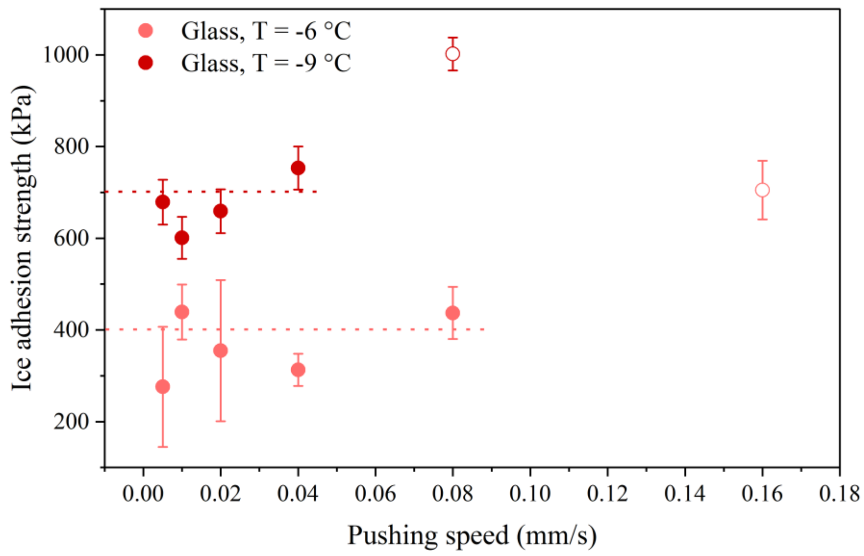

Figure SI1. Effect of pushing speed on ice adhesion strength at -6 (red line and data points) and -9 °C (dark red line and data points) on glass; open symbols indicate brittle detachment. Ice adhesion strength was calculated as F/A (where F is the maximum force of the curve and A the contact area between ice and sample) for both sliding and brittle detachment (average minimum three measurements).

X-RAY PHOTOELECTRON SPECTROSCOPY DETAILS

Spectra were acquired at a base pressure of 5 10-8 Pa using a focused scanning monochromatic Al-K_a source (1486.6 eV) with a spot size of 200 μm and 47.6 W. The instrument was run in the FAT analyzer mode with electrons emitted at 45° to the surface normal. Pass energy used for survey scans was 187.85 eV and 46.95 eV for detail spectra. Charge neutralization utilizing both a cool cathode electron flood source (1.2 eV) and very low energy Ar^+–ions (10 eV) was applied throughout the analysis. Data were analyzed using the program CasaXPS [Version 2.3.16 Pre-rel 1.4]. The signals were integrated following Shirley background subtraction. Sensitivity factors were calculated using published ionization cross–sections[1] corrected for attenuation, transmission-function of the instrument and source to analyzer angle. As a result, the measured amounts are given as apparent normalized atomic concentration and the accuracy under the chosen condition is approximately ±10%.

The spectra of C 1s region, of both freshly prepared and already tested samples, are shown in Figure SI1(a), while the survey spectra are shown in Figure SI1(b). An increase in the total carbon atomic percentage, primarily due to the rise in the C–O (286.69 eV) component characteristic of the polysaccharides, supports polysaccharide layer formation. The thickness of the polysaccharide layers was estimated to be 5–10 nm. This conclusion is supported by the fact that the SiO_2 signal from the substrate remains detectable, although attenuated, after polysaccharide deposition. Considering that the XPS detection depth is up to approximately 10 nm, this observation indicates successful monolayer deposition. After performing ice adhesion tests, the polysaccharide monolayers are thinner, but still present, with some additional adventitious carbon contamination (Figure SI1(a)).

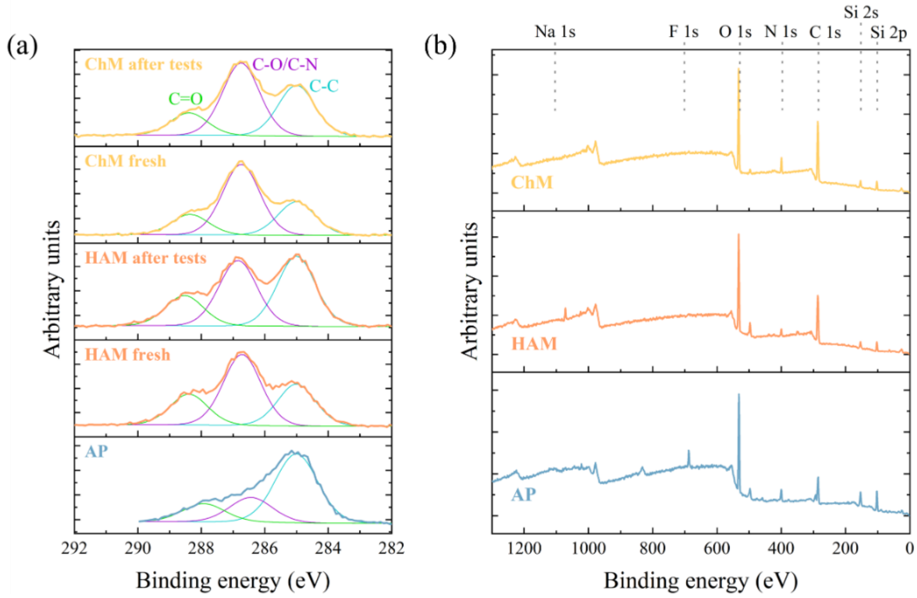

Figure SI2. (a) XPS spectra of C 1s region confirm the successful polysaccharide monolayers deposition with the increase in C-O polysaccharide component ("fresh" samples). After ice adhesion tests, polysaccharide monolayers are thinner, but still present, with some additional adventitious carbon contamination ("after tests" samples). (b) Survey spectra of glass functionalized with the adhesion promoter (AP), hyaluronic acid monolayer (HAM) and chitosan monolayer (ChM). Main peaks are indicated.

CONTACT ANGLE MEASUREMENTS

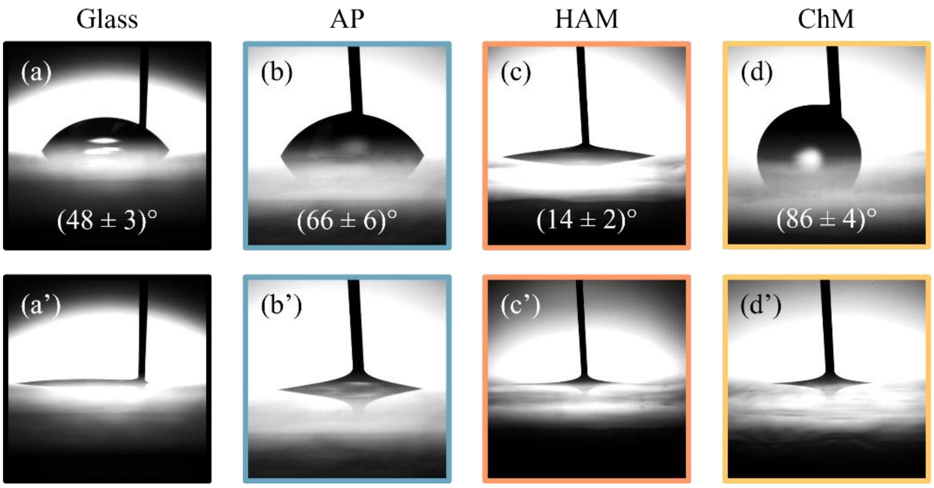

Figure SI3. Pictures of advancing contact angles (average of four measurements) of distilled water on (a) glass, (b) glass functionalized with adhesion promoter (AP), (c) hyaluronic acid monolayer (HAM) and (d) chitosan monolayer (ChM) and of receding contact angles of distilled water on (a') glass, (b') AP, (c') HAM and (d') ChM.

ICE ADHESION MEASUREMENTS ON CHITOSAN COATINGS WITH DIFFERENT MOLECULAR WEIGHTS

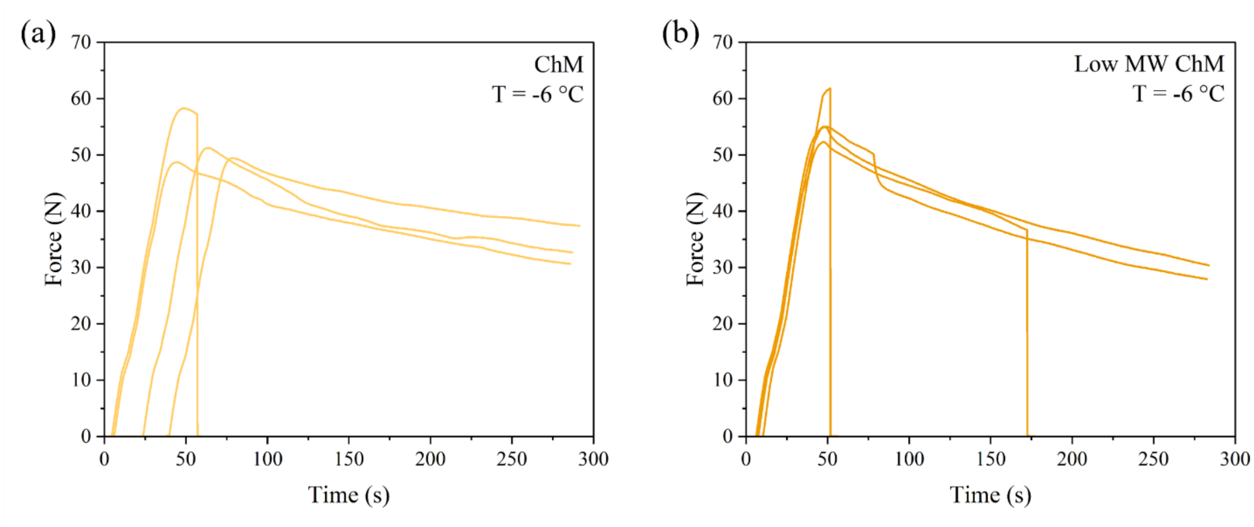

Figure SI4. Ice adhesion measurements (T = -6 °C; pushing speed = 0.01 mm/s) performed on (a) chitosan monolayer (ChM; as shown in the main text) and low molecular weight chitosan monolayer (Low MW ChM). This comparison shows that there is no difference between the performance of the two types of chitosan.

SAMPLE DURABILITY

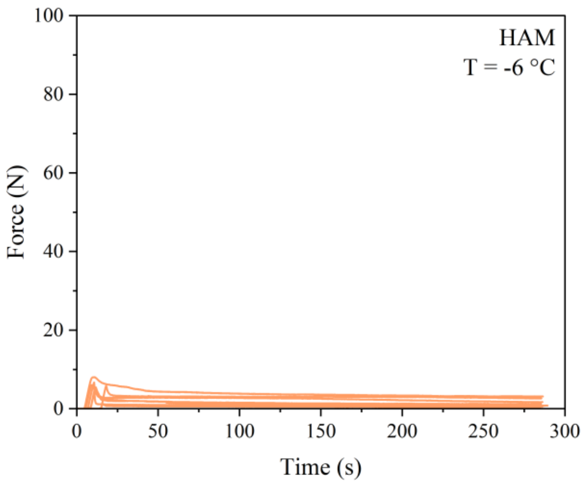

Figure SI5. Ice adhesion measurements (T = -6 °C; pushing speed = 0.01 mm/s) on hyaluronic acid monolayer (HAM), showing that the results are still the same even after 7 measurements. Thus, for each tested temperature, a different sample was used, and four measurements were performed on each sample for a defined condition, to ensure result reproducibility.

1 J. H. Scofield, *Journal of Electron Spectroscopy and Related Phenomena*, 1976, **8**, 129–137.