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Exponential growth of layer-by-layer assembled coatings with well-dispersed ultrafine nanofillers: a facile route to scratch-resistant and transparent hybrid coatings

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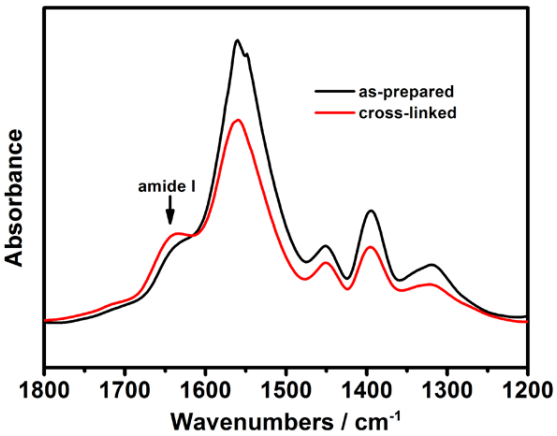

Figure S1. FT-IR absorbance spectra of the as-prepared (black line) and thermally cross-linked (red line) (PAA-$CaCO_3$/PAH)*30 coatings. The appearance of the amine I peak at ~1640 cm^{-1} in the FT-IR spectrum of the thermally cross-linked (PAA-$CaCO_3$/PAH)*30 coating confirms the formation of amide bonds between the amine groups of PAH and the acid groups of PAA.

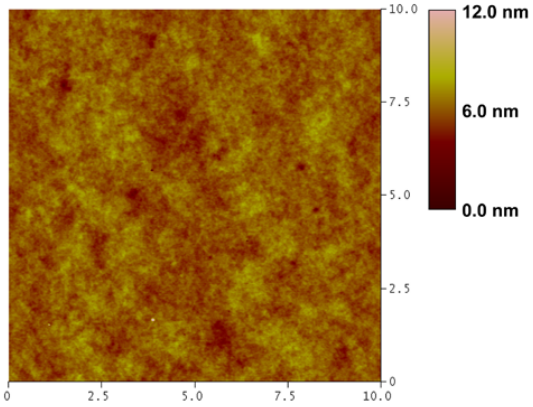

Figure S2. AFM image of the cross-linked (PAA-$CaCO_3$/PAH)*20 coating. The coating has a root-mean-square (rms) roughness of 0.8 nm as measured by atomic force microscopy.

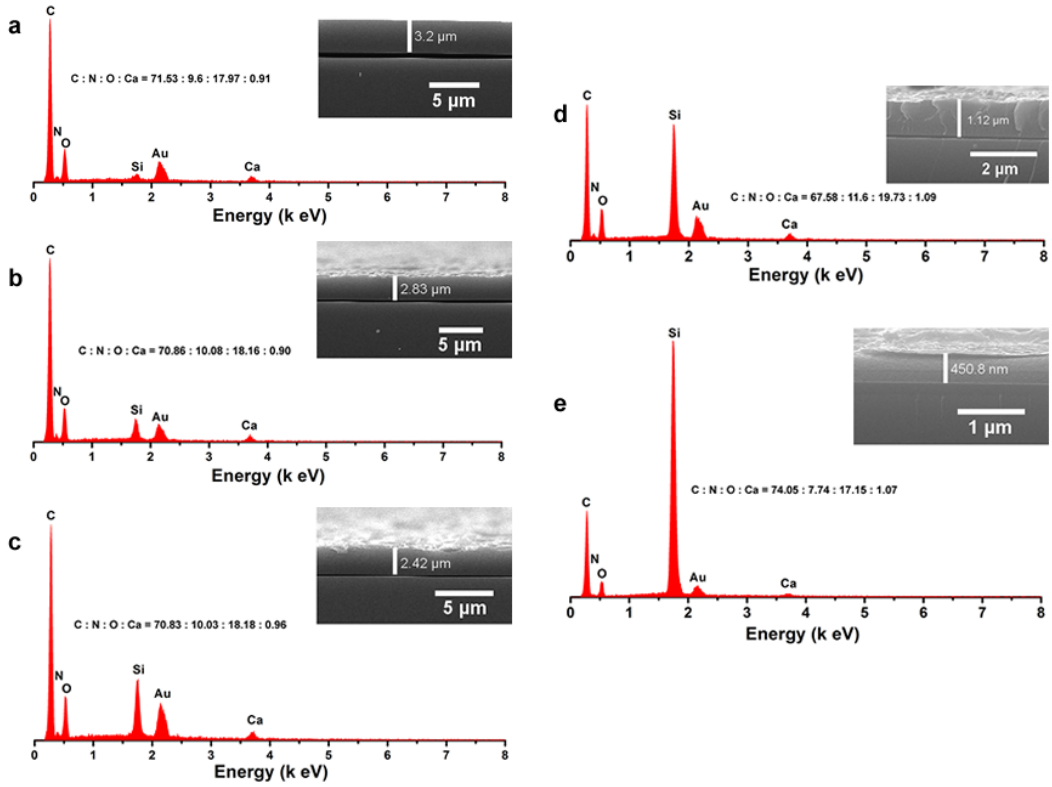

Figure S3. The energy dispersive X-ray (EDX) spectra of a thermally cross-linked (PAA-$CaCO_3$/PAH)*30 coating which was scratched with a sharp scalpel to different depth. a) Before scratching, b-e) The (PAA-$CaCO_3$/PAH)*30 coatings with a residual thickness of 2.83 µm (b), 2.42 µm (c), 1.12 µm (d) and 0.45 µm (e).

The energy dispersive X-ray analysis (EDX) has a deep depth detection which allows to identifying element distribution in the whole (PAA-$CaCO_3$/PAH)*30 coating, as the Si signal from the underlying silicon substrate is detected for the 3.2-µm-thick (PAA-$CaCO_3$/PAH)*30 coating. With more layers being removed from

(PAA-$CaCO_3$/PAH)*30 coating, the intensity of Si signal in the corresponding EDX spectra increases gradually. The constant ratio of Ca to C, N and O in the coatings confirms the homogeneous dispersing of $CaCO_3$ in the normal direction of the (PAA-$CaCO_3$/PAH)*30 coating.

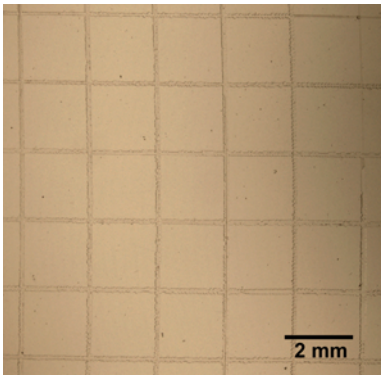

Figure S4. Optical image of a thermally cross-linked (PAA-$CaCO_3$/PAH)*20 coating deposited on a glass substrate after adhesion test. The (PAA-$CaCO_3$/PAH)*20 has a ASTM class 5B adhesion with the underlying glass substrate, which represents the highest level of adhesion.

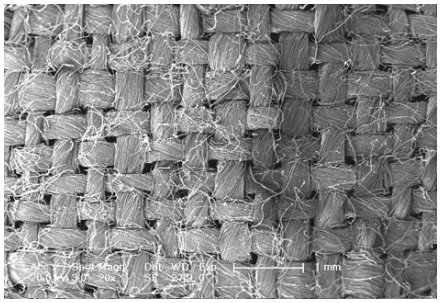

Figure S5. Top-view SEM image of the piece of ramee cloth used in the rubbing test.