Supporting Information

Table S1. Percent degree of methacrylation of different macromer size HA when reacting with various molar ratio of methacrylic anhydride.

MW of HA	**HA monomer : Methacrylic anhydride molar ratio**			
	1:3	1:6	1:10	1:12
47 kDa	~ 10%	~ 40-50%	~ 80%	~ 100%
310 kDa	N/A	~ 30%	N/A	~ 75%
1 MDa	N/A	Not detectable	N/A	N/A

N/A data not available

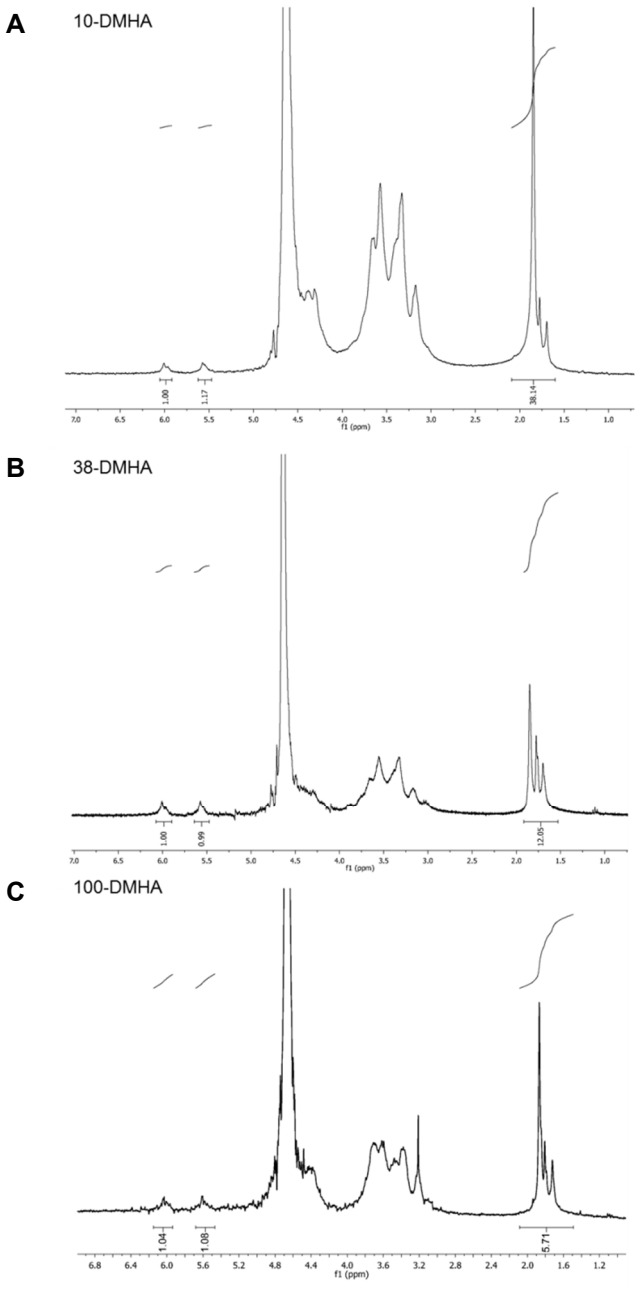

Figure S1. ^{1}H NMR spectra of methacrylated HA with 10% (A), 38% (B), and 100% (C) degree of modification.

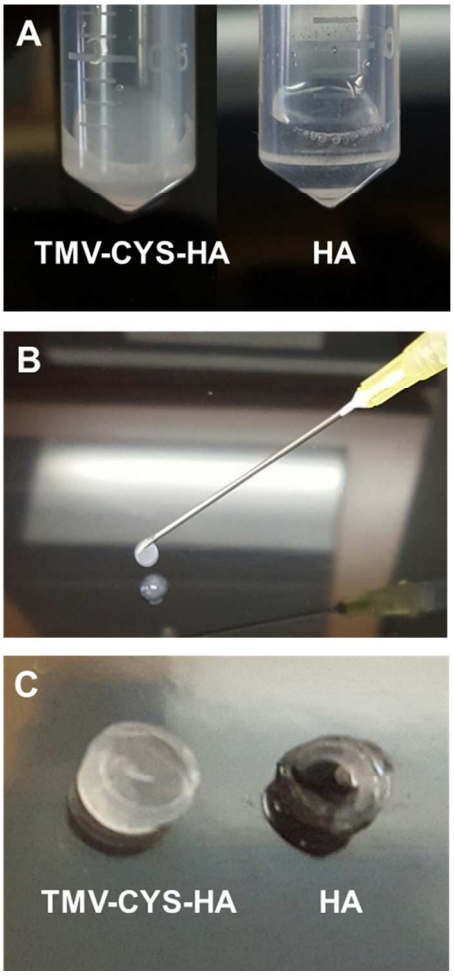

Figure S2. Illustration of the *in situ* hydrogel formation. (A) The pre-hydrogel mixture with TMV1cys (left) and without TMV1cys (right). (B) Injectable simulation of pre-hydrogel mixture through needle 20G. (C) The TMV1cys based HA hydrogel (left) and HA hydrogel (right) after gelation for 2 h.

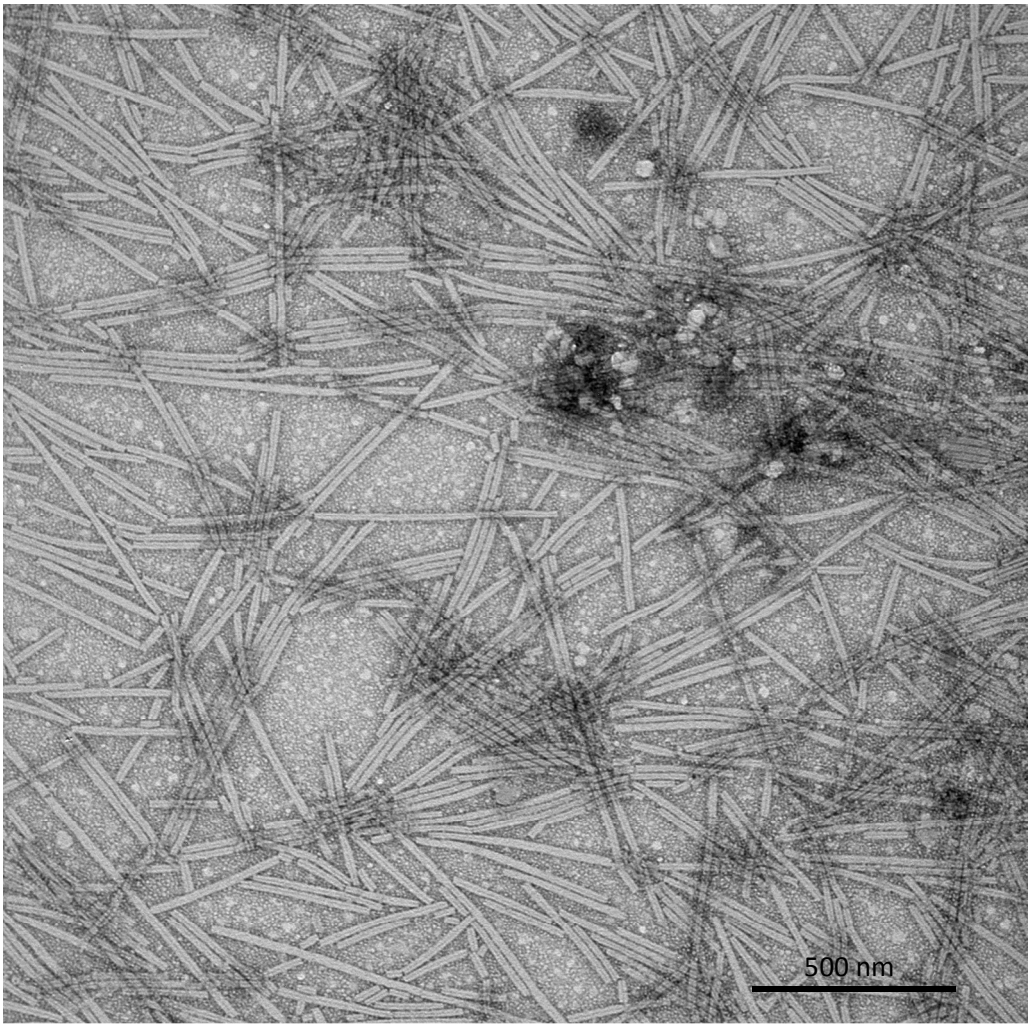

Figure S3. Transmission electron micrograph of TMV1cys.

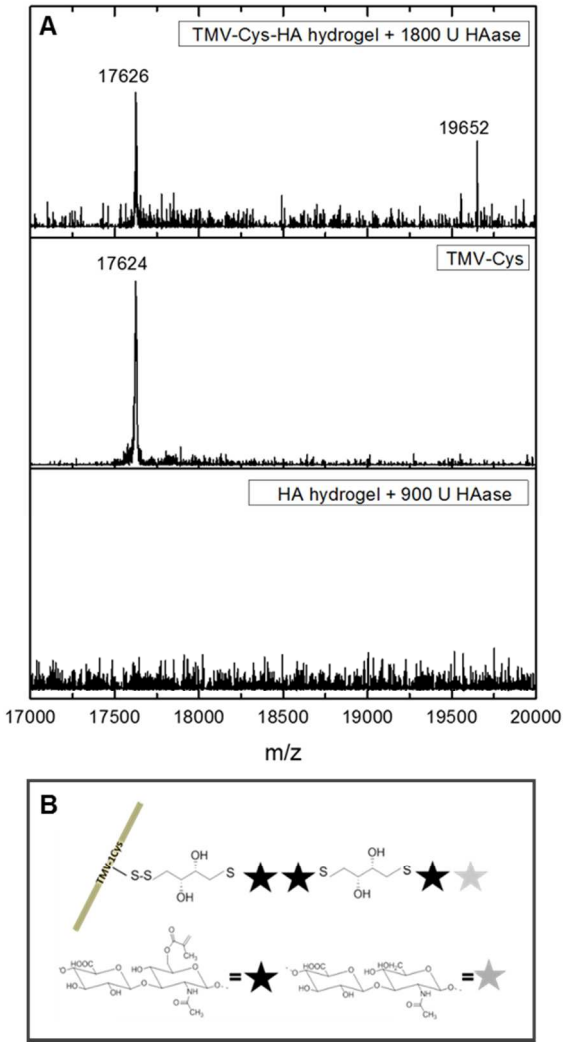

Figure S4. Interaction of TMV1cys and its structural integrity in the HA hydrogel. (A) MALDI-TOF spectra compared the m/z profiles of the TMV1cys based hydrogel after enzyme digestion of HA backbone (top panel) with the virus alone (middle panel) and with the control HA hydrogel (last panel). (B) The proposed structure of the TMV1cys based HA hydrogel from MALDI-TOF analysis, the TMV1cys covalently interacted with the polymer backbone.

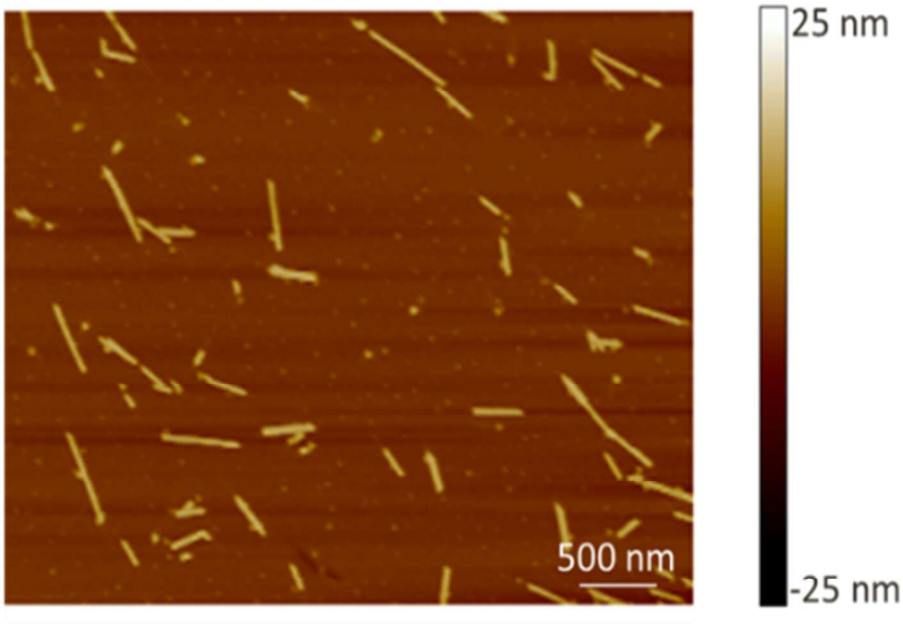

Figure S5. Atomic force microscopy height image of the TMV1cys based HA hydrogel, showing the presence of TMV1cys intact particles in the hydrogel.

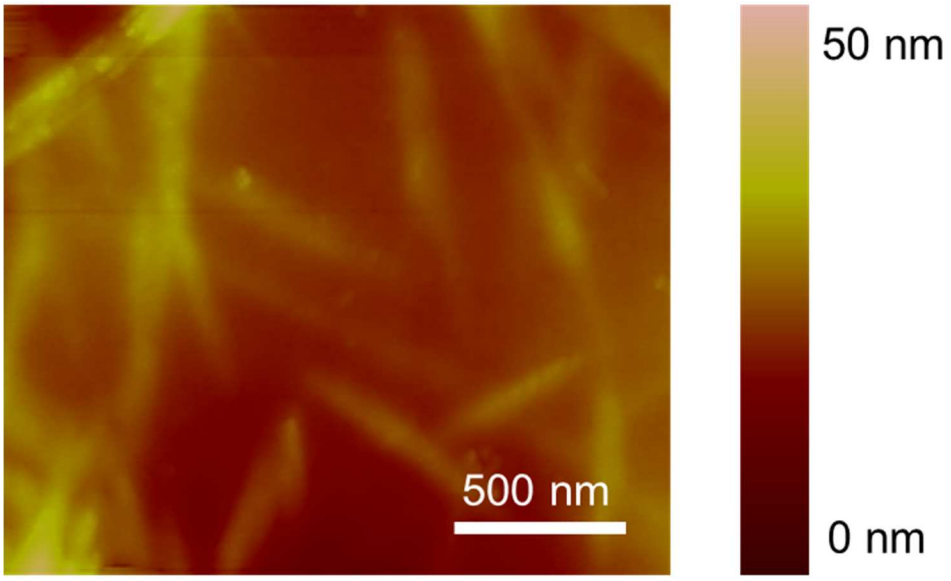

Figure S6. Atomic force microscopy height image of the TMV1cys based HA hydrogel after keeping more than 6 months, showing the presence of TMV1cys intact particles in the hydrogel.

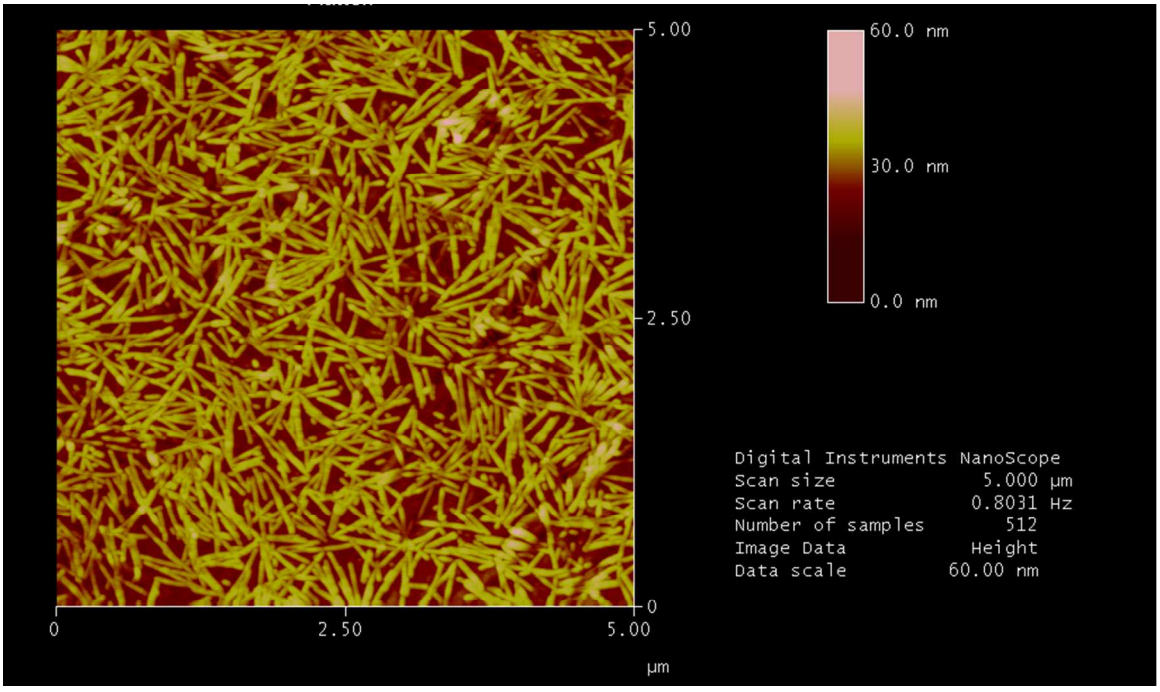

Figure S7. Atomic force microscopy of wild-type TMV.

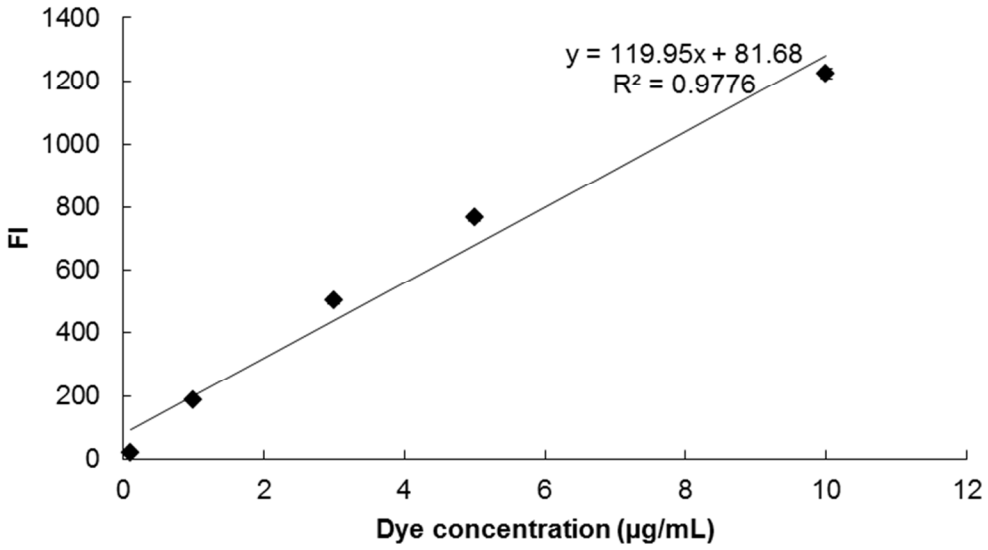

Figure S8. Fluorescence spectroscopy calibration with linear fitting curve and equation for quantification of fluorescein amine isomer I.

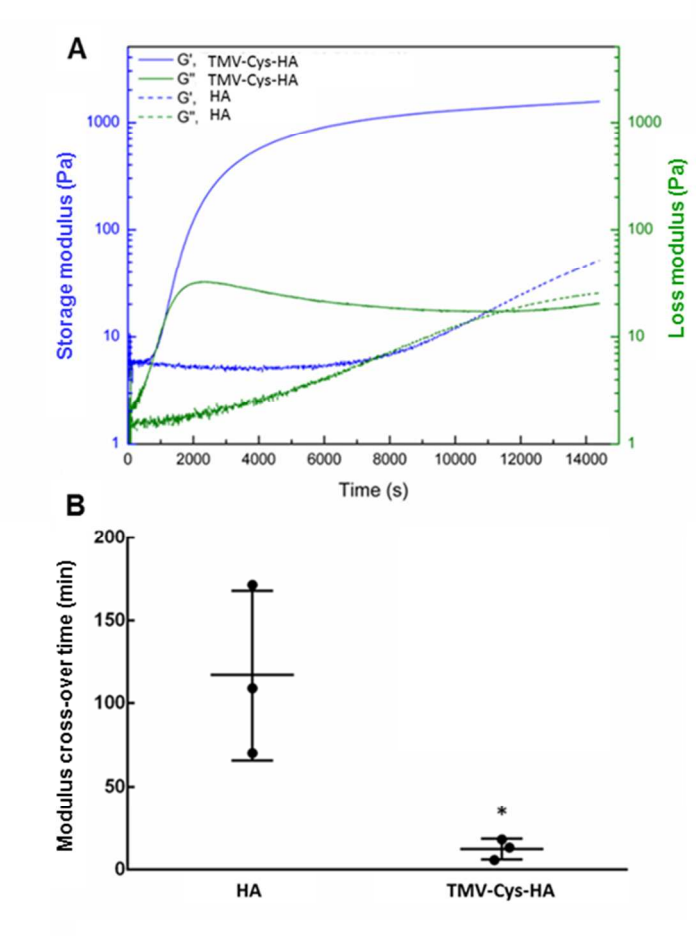

Figure S9. (A) Gelation behavior of the hydrogels was observed via oscillation time sweep at 25 °C, 2% strain and 10 rad/s frequency. (B) The average gelation time of the hydrogels. The horizontal bars are means ± SD with each data expressed in dot plots (n = 3); *$p < 0.05$.