Electronic Supplementary Information

Single microgel degradation governed by heterogeneous nanostructures

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Results and Discussion

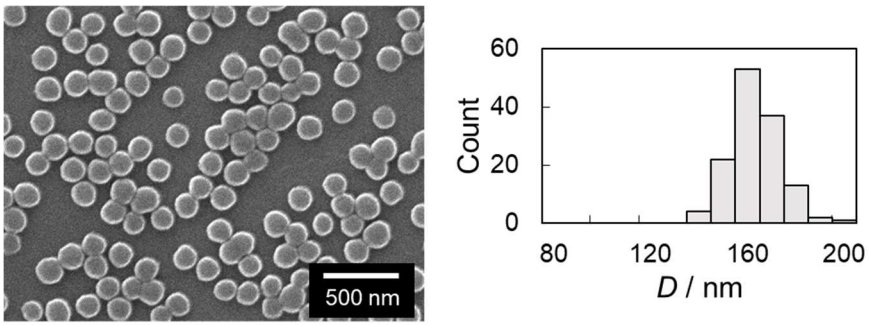

Fig. S1. Field-emission scanning electron microscopy (FE-SEM) image and the corresponding size histogram (N = 132) of the NB10 microgels.

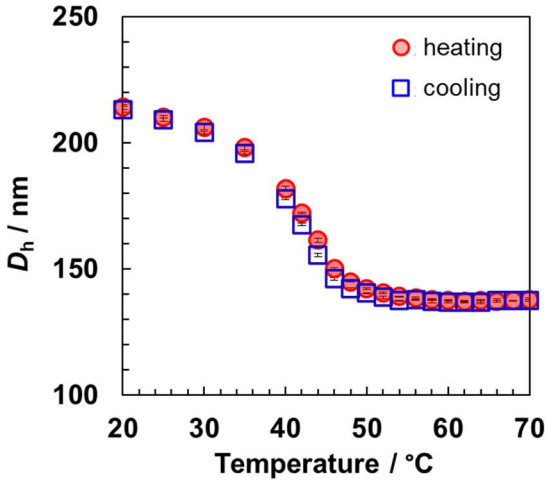

Fig. S2. Temperature dependence of the hydrodynamic diameter (D_h) of the NB10 microgels during heating and cooling, as derived from dynamic light-scattering (DLS) measurements. The ionic strength was adjusted to 1 mM using NaCl.

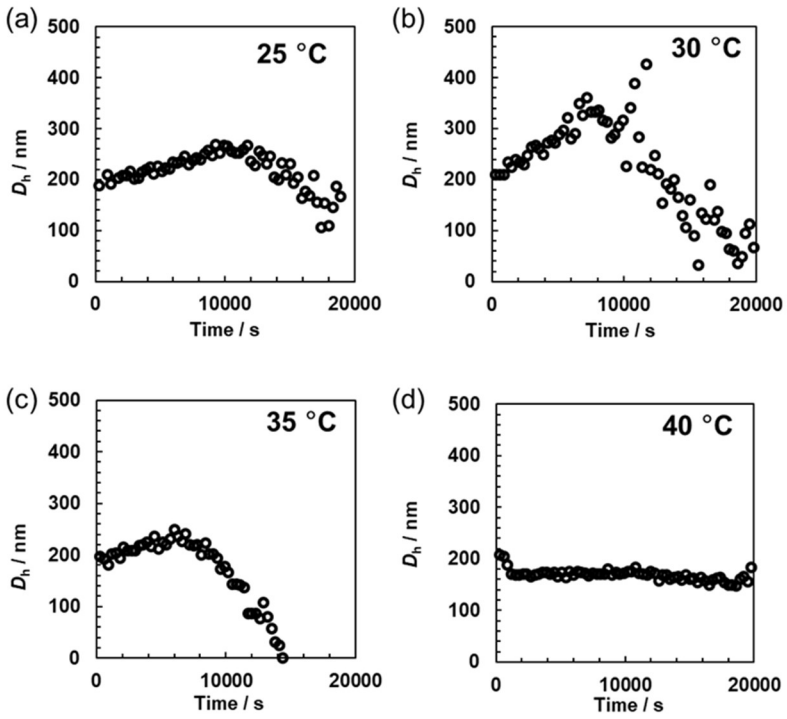

Fig. S3. Changes to the D_h and polydispersity index (PDI) of ND microgels during degradation at different temperatures: (a) 25 °C, (b) 30 °C, (c) 35 °C, and (d) 40 °C. The microgel and $NaIO_4$ concentrations were 0.005 wt.% and 50 mM, respectively. The D_h reached its maximum value earlier and the degradation rate was increased with increasing temperature (9900 s, 8100 s, and 6000 s at 25 °C, 30 °C, and 35 °C, respectively). In contrast, at 40 °C, which was defined as the semi-swollen state, little swelling of the microgels was observed, and the decrease in D_h was significantly delayed (to 10800 s) compared to that at 35 °C.

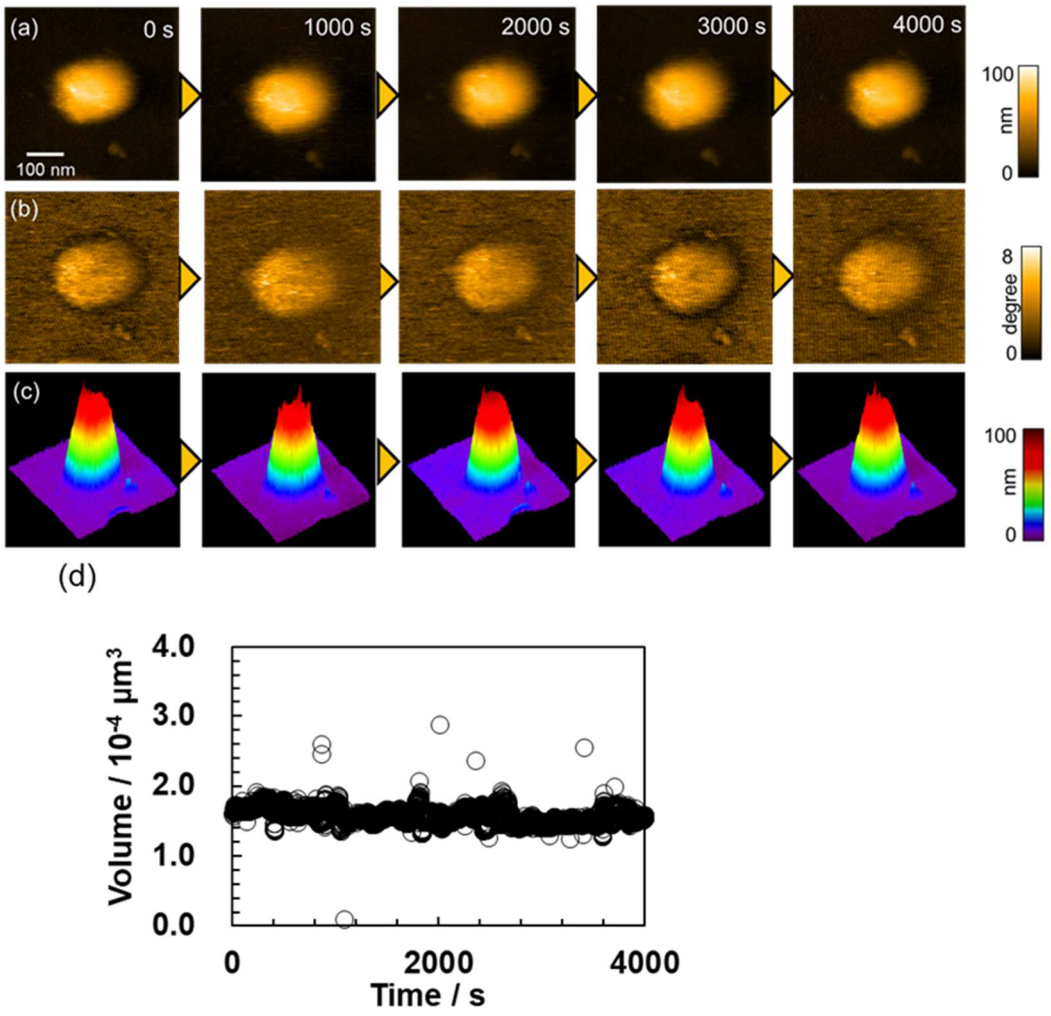

Fig. S4. Time dependence of the (a) height images, (b) phase images, (c) 3D images, and (d) volume of an ND10 microgel in the absence of $NaIO_4$ at 30 °C. The structural changes did not occur, indicating that the imaging process did not significantly affect the degradation of the microgels.

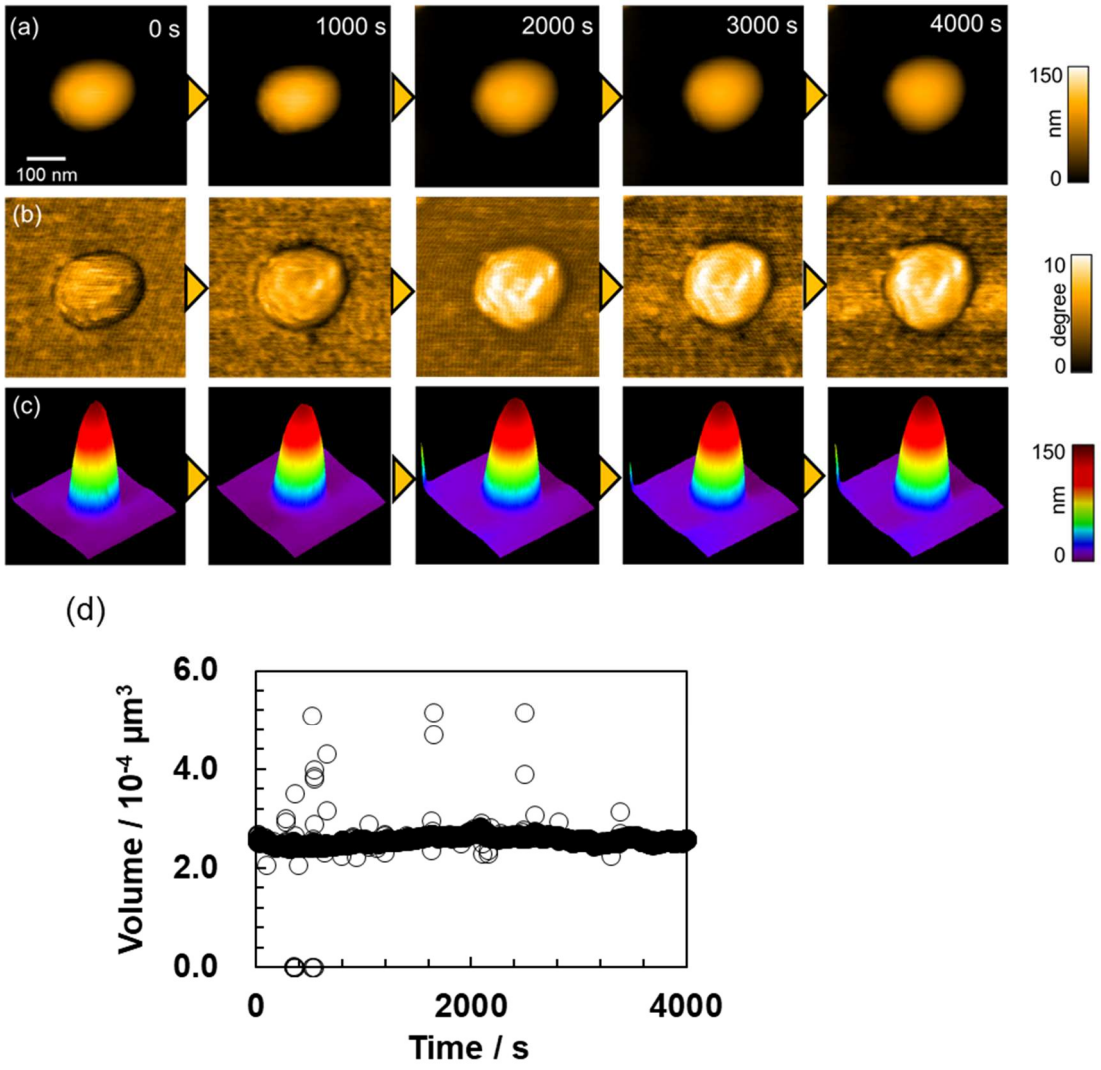

Fig. S5. Time dependence of the (a) height images, (b) phase images, (c) 3D images, and (d) volume of the NB10 microgel in the presence of 62.5 mM $NaIO_4$ at 30 °C. The results show that degradation of the microgels is caused by cleavage of the cross-linker.

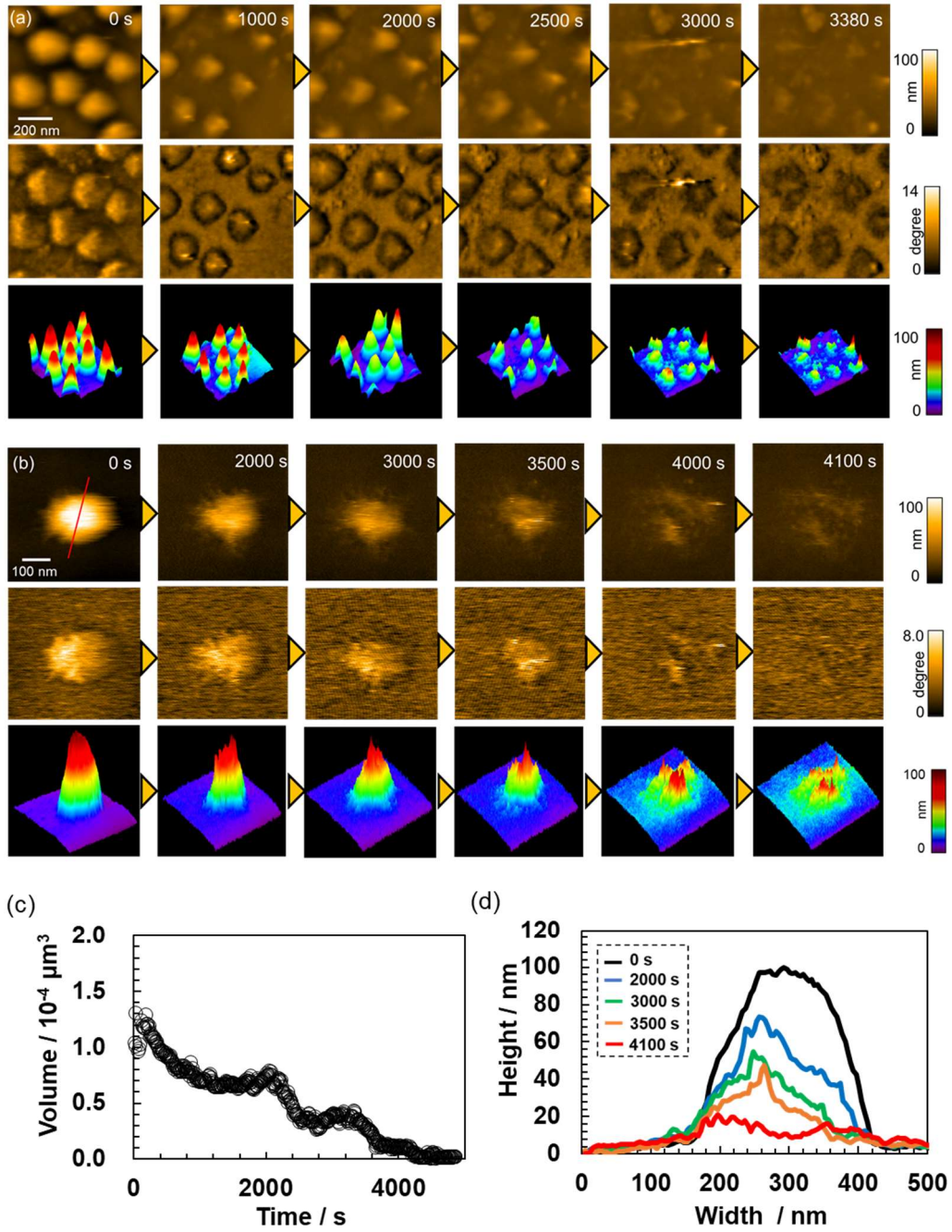

Fig. S6. Time dependence of height images, phase images, and 3D images obtained from the HS-AFM analysis during the degradation of ND10 at 25 °C in the presence of 62.5 mM $NaIO_4$: (a) Wide-range imaging and (b) single-particle imaging; (c) volume changes of a single microgel and (d) cross-sectional profiles corresponding to the red line in (b).

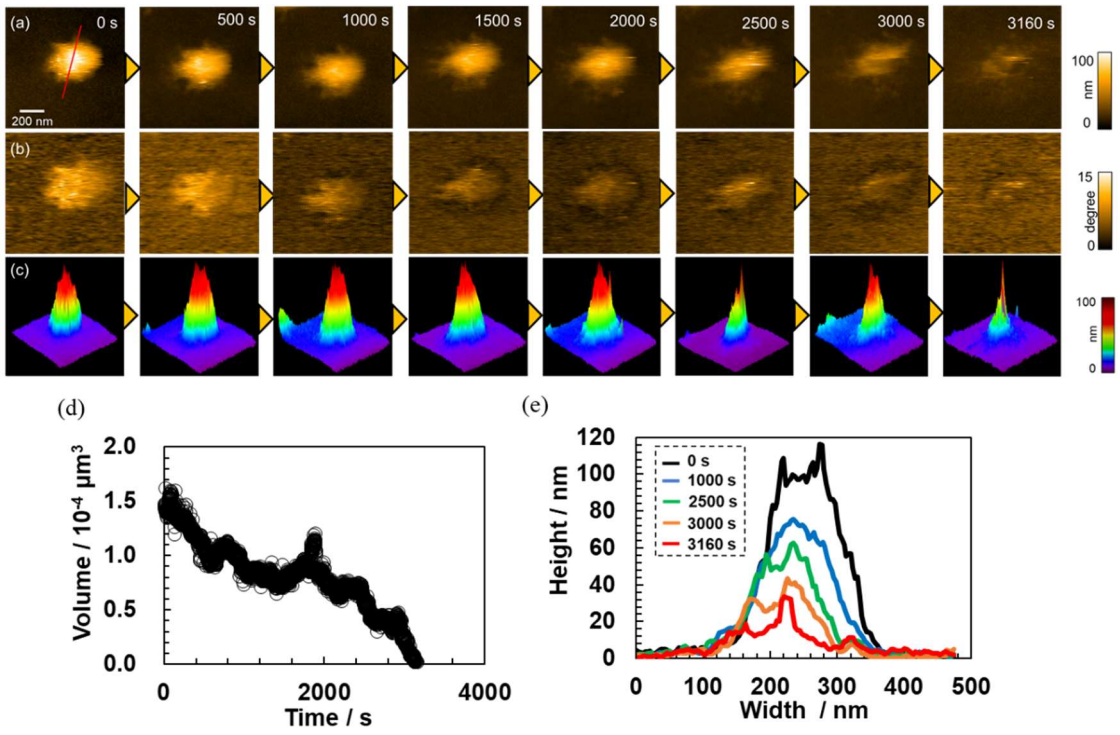

Fig. S7. Time dependence of (a) height images, (b) phase images, (c) 3D images, (d) volume, and (e) cross-sectional profiles corresponding to the red line in (a) for a single ND10 microgel during degradation in the presence of 62.5 mM $NaIO_4$ at 35 °C.

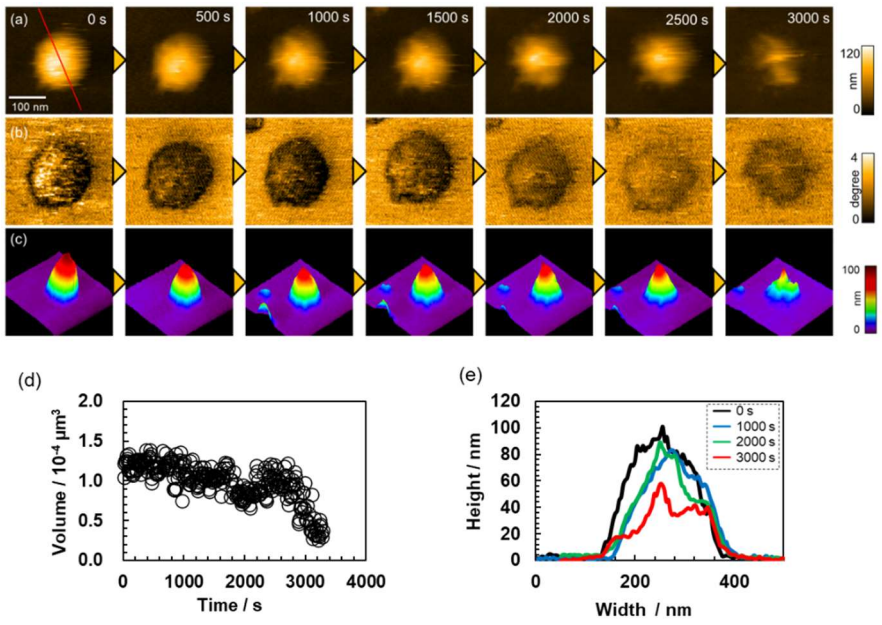

Fig. S8. Confirmation of reproducibility for a single ND10 microgel degradation behavior in the presence of 62.5 mM $NaIO_4$ at 35 °C. Time dependence of (a) height images, (b) 3D images, (c) volume, and (d) cross-sectional profiles corresponding to the red line in (a).

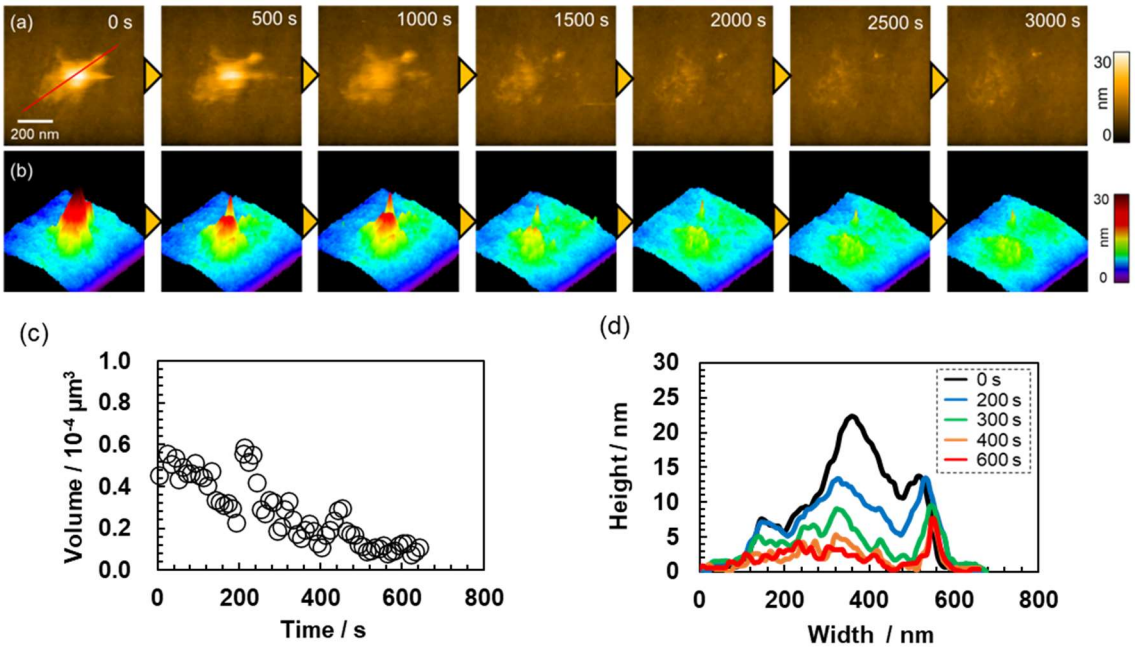

Fig. S9. The effect of cross-linking density of ND microgels on the degradation behavior. Time dependence of (a) height images, (b) phase images, (c) 3D images, (d) volume, and (e) cross-sectional profiles corresponding to the red line in (a) for a single ND5 microgel (swelling ratio = 11) during degradation in the presence of 62.5 mM $NaIO_4$ at 25 °C. It should be noted that ND microgels with higher cross-linking density were not obtained; ND15 microgels were aggregated during polymerization.

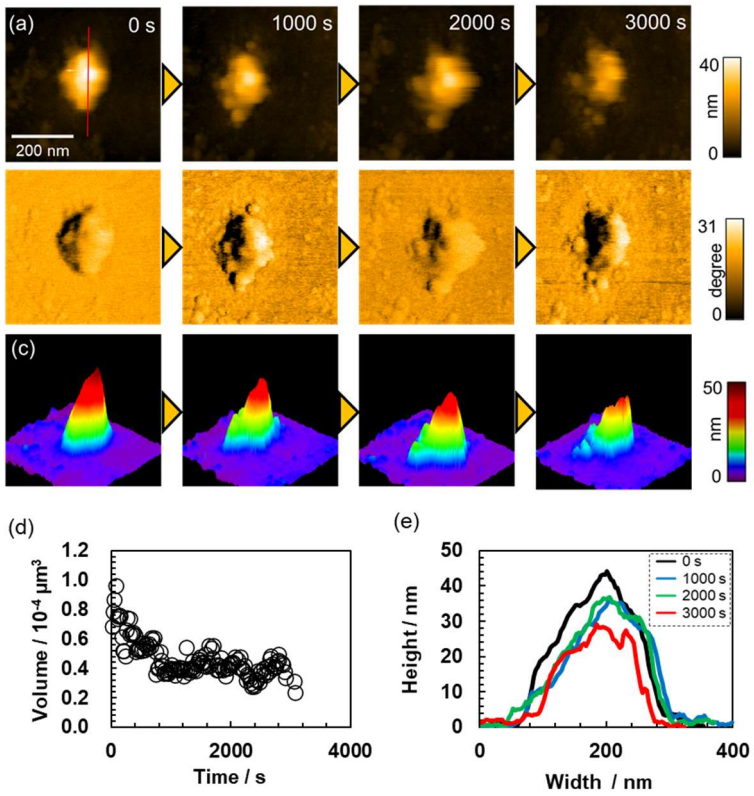

Fig. S10. Confirmation of reproducibility for a single ND10 microgel degradation behavior in the presence of 62.5 mM $NaIO_4$ at 40 °C. Time dependence of (a) height images, (b) phase images, (c) 3D images, (d) volume, and (e) cross-sectional profiles corresponding to the red line in (a).

Movie S1. Height movie of ND10 microgels during degradation at 30 °C. The $NaIO_4$ concentration was 62.5 mM.

Movie S2. Height movie of the degradation of a single ND10 microgel at 30 °C. The $NaIO_4$ concentration was 62.5 mM.

Movie S3. Height movie of the degradation of a single ND10 microgel at 25 °C. The $NaIO_4$ concentration was 62.5 mM.

Movie S4. Height movie of the degradation of a single ND10 microgel at 35 °C. The $NaIO_4$ concentration was 62.5 mM.

Movie S5. Height movie of the degradation of a single ND10 microgel at 40 °C. The $NaIO_4$ concentration was 62.5 mM.