Supplementary information

Following polymer degradation with nanodiamond magnetometry.

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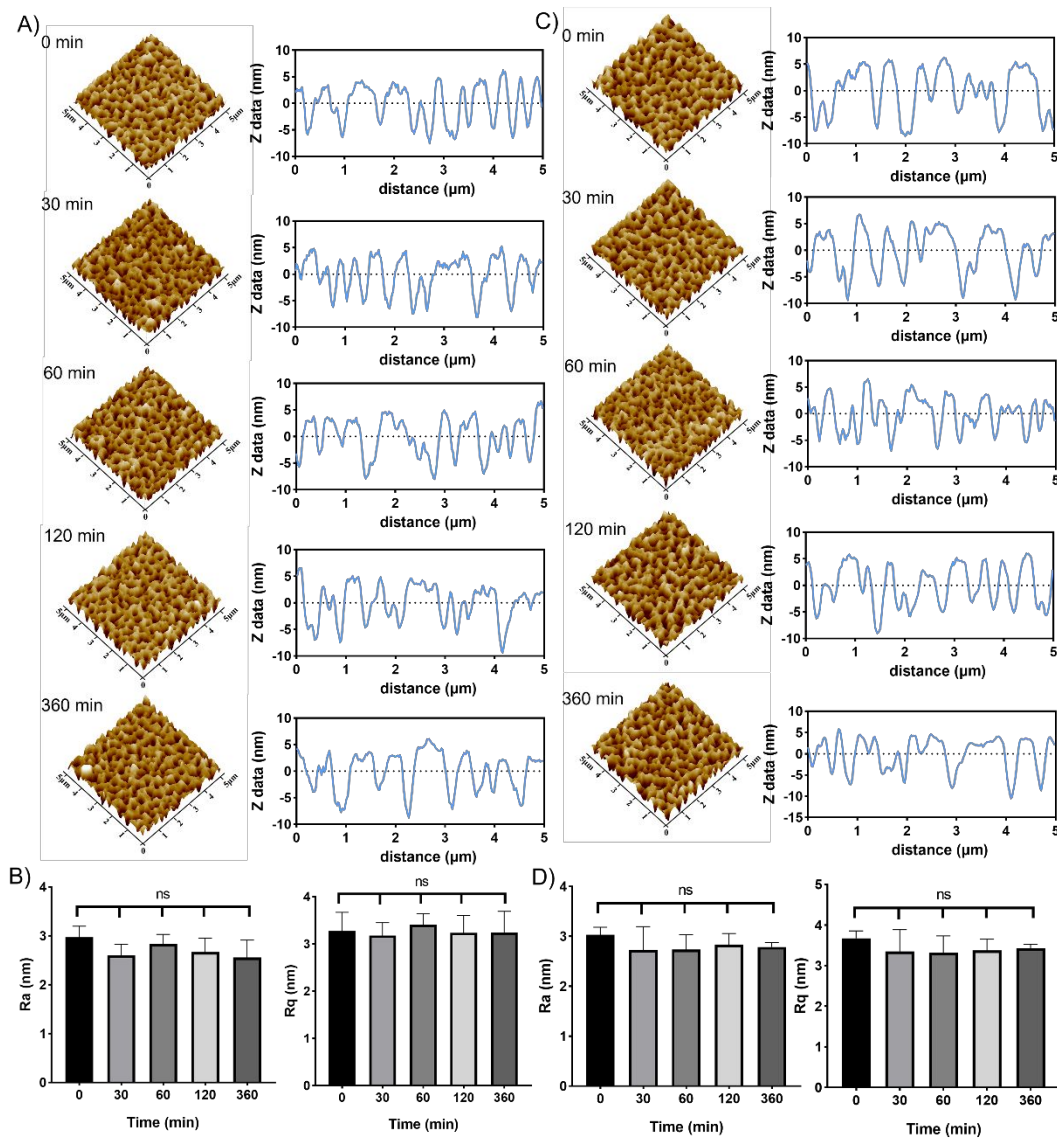
# These two authors contributed equally

Figure S1. Contacting mode 3D AFM images of PLA film surfaces, z-profiles cross the surface were shown after PLA film was treated with pH 7 and pH 10 solution for 0 min, 30 min, 60 min, 120 min and 360 min. Corresponding surface roughness parameters, including arithmetic mean roughness Ra and

RMS roughness Rq were calculated from the AFM images as well. (A) the PLA film before pH 7 solution degradation and the PLA film treated with pH 7 solution. (B) Ra and Rq of AFM images before and after pH 7 treatment. (C) the PLA film before pH 10 solution degradation and the PLA film treated with pH 10 solution. (D) Ra and Rq of AFM images before and after pH 10 treatment.
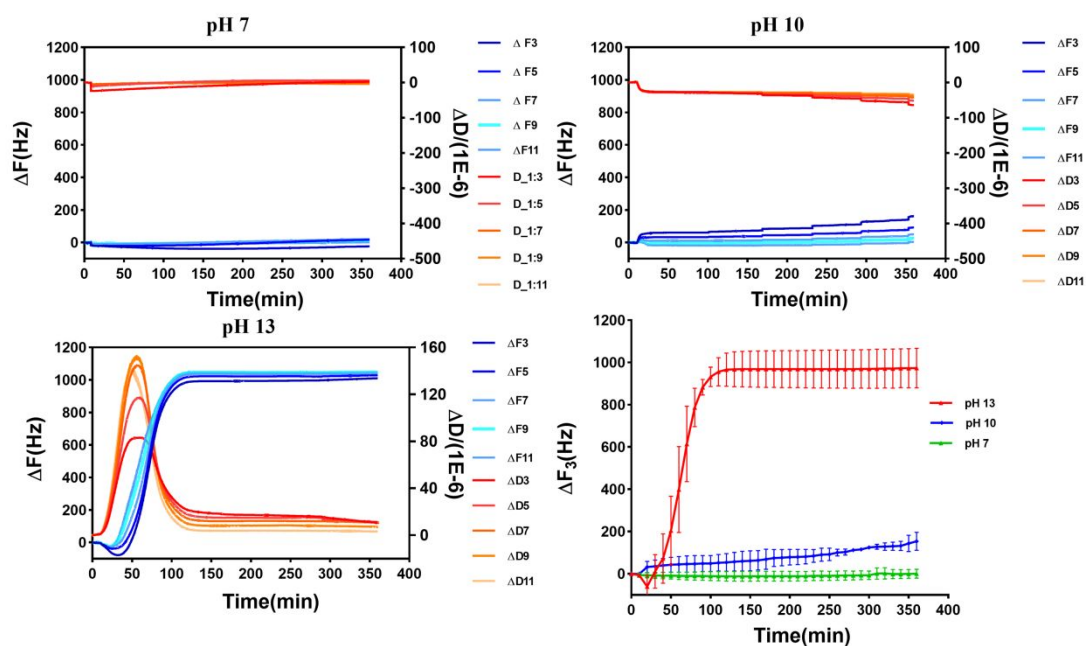

Figure S2. QCM-D monitoring of resonance frequency (ΔF, blue) and dissipation (ΔD, orange) at several overtones (n=3, 5, 7, 9 and 11) were obtained over time during pH 7 (a), pH 10 (b) and pH 13 (c) solutions at 25 °C. ΔF_3 as a normalized frequency were compared in different experimental sets (d).
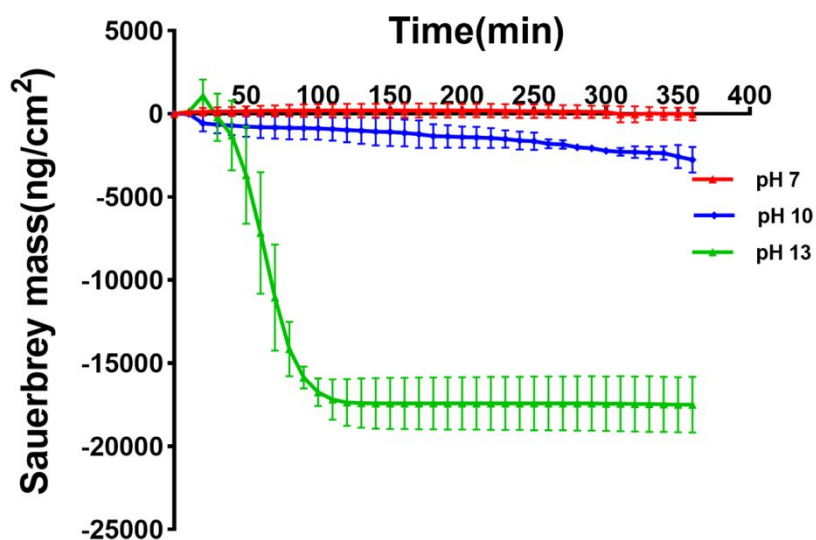

Figure S3. The mass versus time plot at pH 7, pH 10 and pH 13 solution at 25 °C, respectively. The mass data were obtained using the Sauerbrey equation (1) from ΔF data.
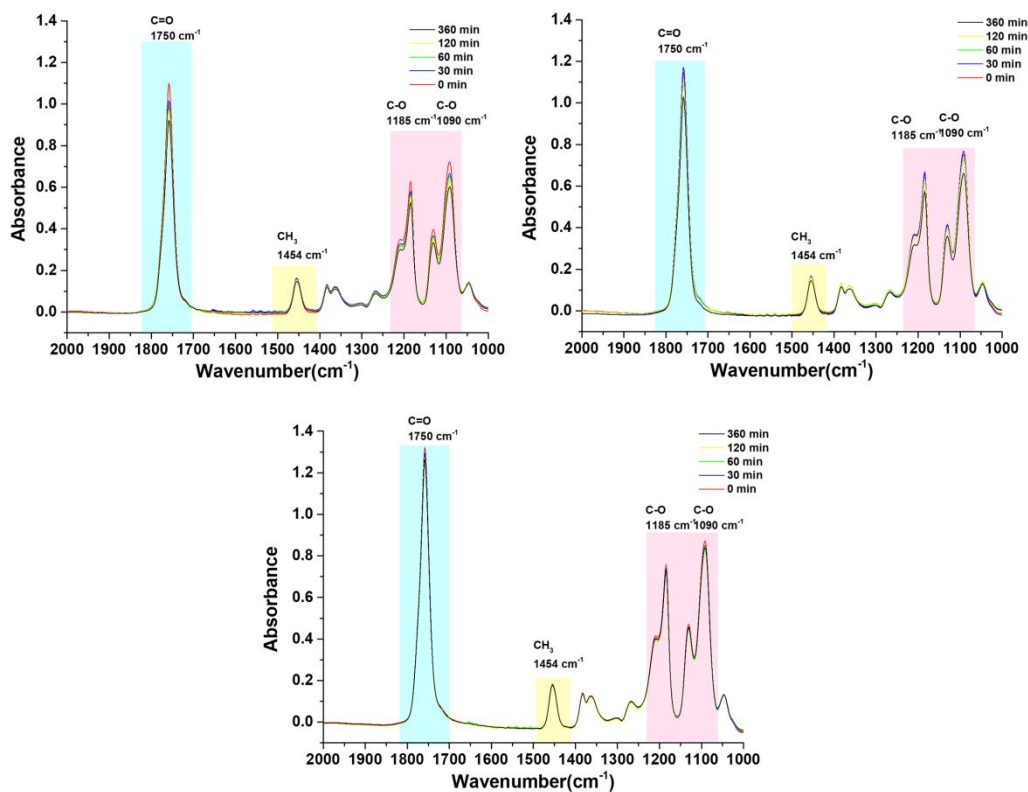
Figure S4. FTIR spectra during degradation was obtained from PLA thin films exposed to pH 13 (a), pH 10 (b) and pH 7 (c). The red line represents before degradation, the blue line, green line, yellow line, and black line represent 30, 60, 120, and 360 minutes after degradation, respectively.
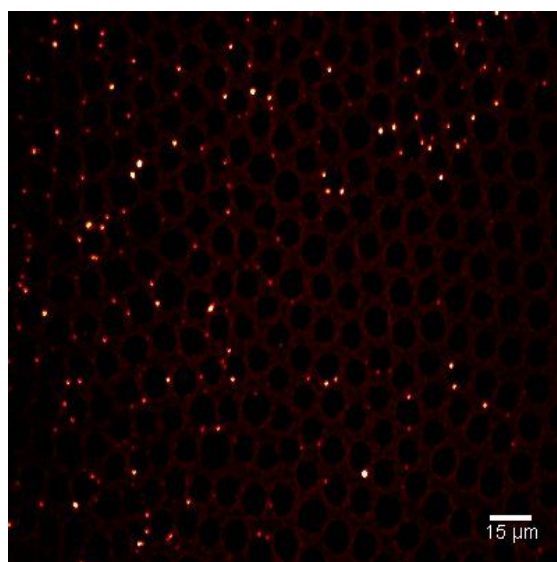

Figure S5. The PLA thin film mixed with 0.1wt% FNDs, red-white dots are FNDs, evenly distributed in the film.
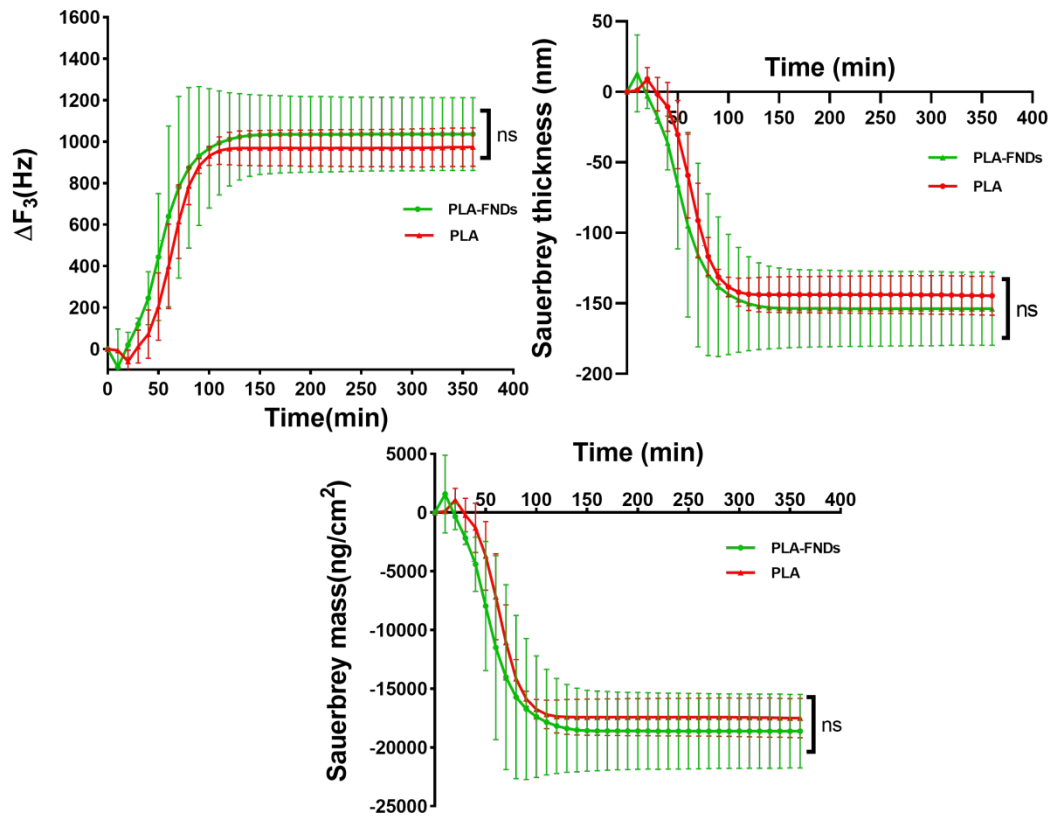
Figure S6. Comparison of degradation of PLA film and PLA with FNDs film after treatment of pH 13 solution, including changes in ΔF, Sauerbrey mass and Sauerbrey thickness. (Statistics were evaluated using Graphpad Prism 8.0.1 by multiple t tests, and p ≤ values 0.05 were considered as significant differences.)

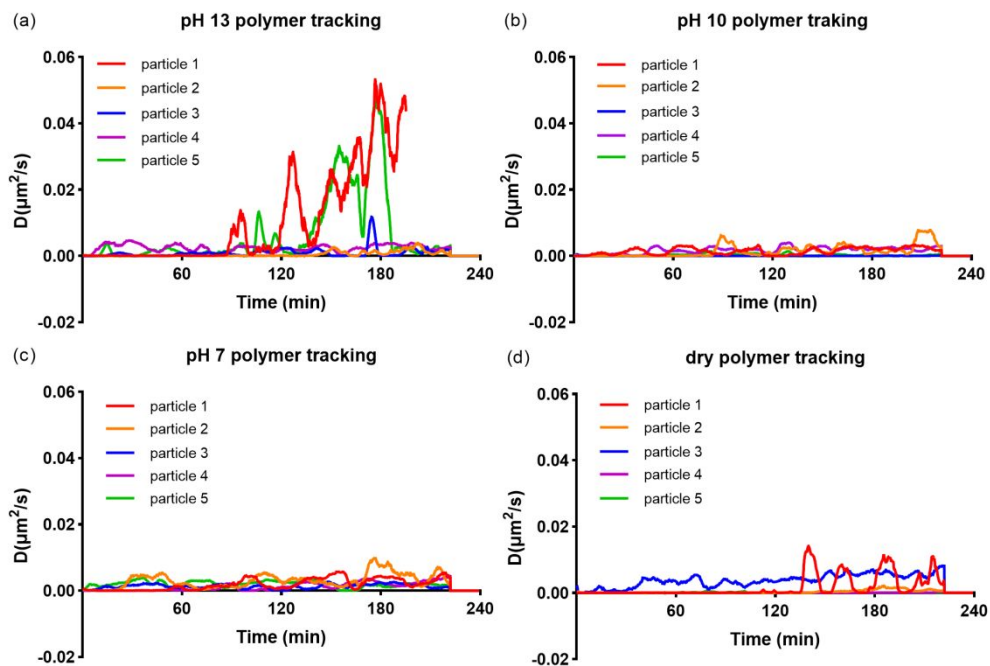**Figure S7.** The diffusion coefficients of five FNDs tracking in each polymer film under pH 13 (a), pH 10 (b) and pH 7 (c), and dry film (d).
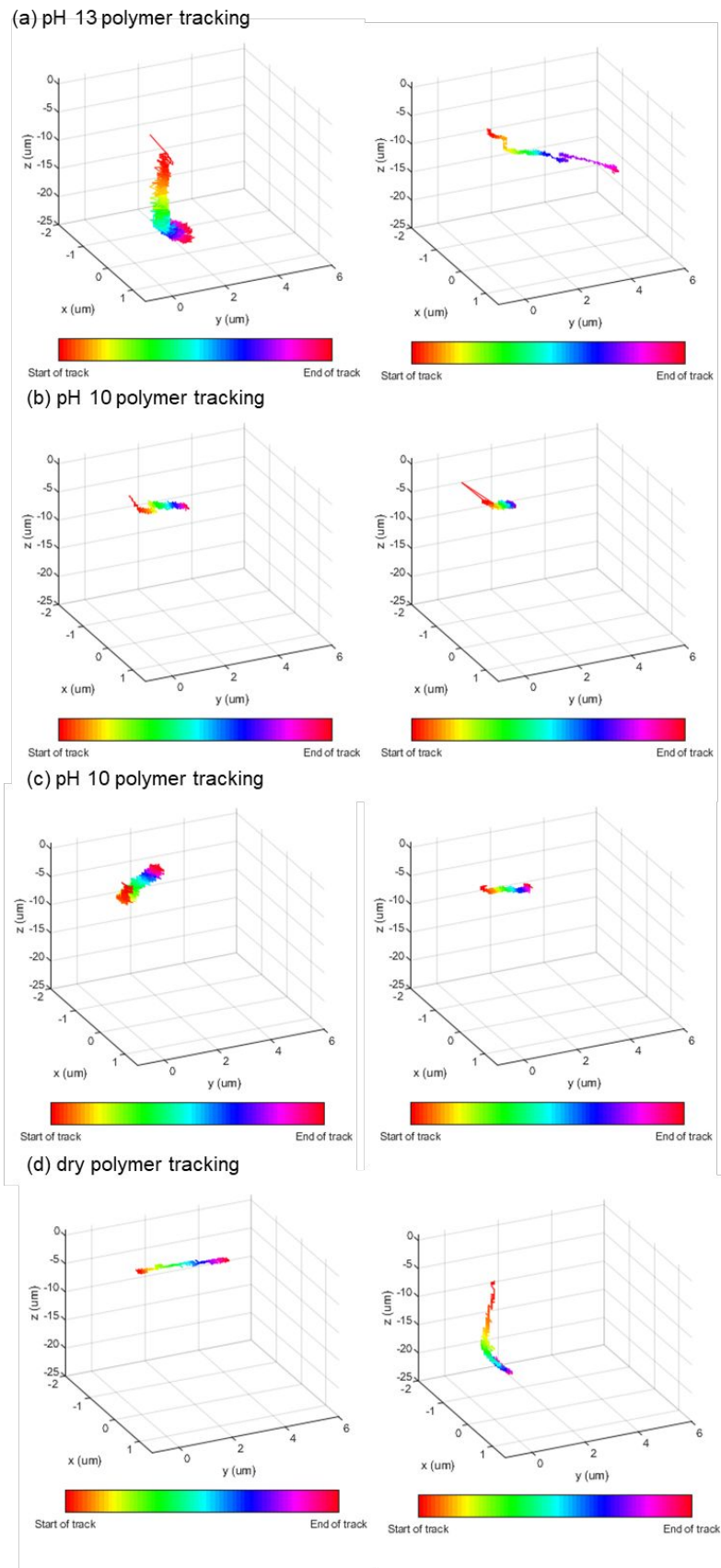
Figure S8. 3D trajectories for particle tracking, two typical FNDs trajectories of the polymer film were shown under pH 13 (a), pH 10 (b) and pH 7 (c), and dry film (d).
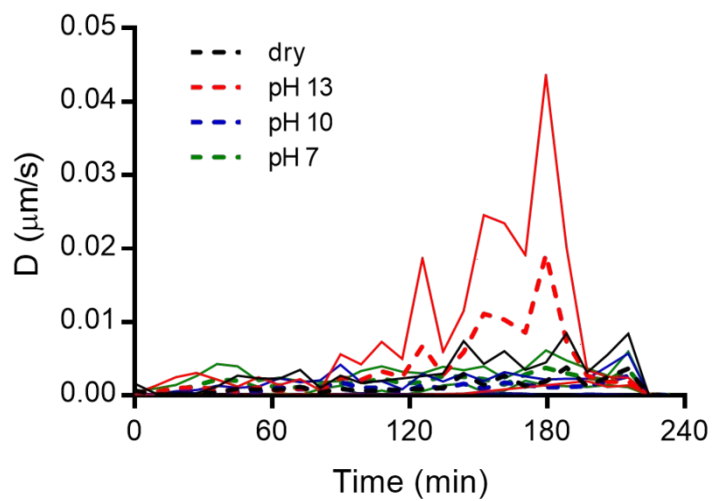

Figure S9. FNDs tracking results with error boundaries. The dotted lines represent the average of the tracks with the solid lines as the error boundaries based on the standard deviation.