

Supplementary data

Effect of Chemical Agents on the Morphology and Chemical Structures of Microplastics

Hak Bong Lee^a, Kyong Sub Lee^a, Seok Jun Kim^b, Byung Il Choi^b, Byung Rye Go^c, Chan Joo Rhu^d, and Tae Hee Han^{a,e*}

^aDepartment of Organic and Nano Engineering, Hanyang University, Seoul 04763, Republic of Korea

^bMaterials & Components Research Institute, Korea Testing & Research Institute, Gyeonggi-do 13810, Republic of Korea

^cProducts Conformity Center, Korea Conformity Laboratories, Seoul 06711, Republic of Korea

^dConsumer Product Center, Korea Conformity Laboratories, Seoul 06711, Republic of Korea

^eThe Research Institute of Industrial Science, Hanyang University, Seoul 04763, Republic of Korea

***Corresponding Authors**

Prof. Tae Hee Han (T. H. Han)

E-mail: than@hanyang.ac.kr

Keywords: microplastic, chemical resistance, chemical digestion, degradation

Keywords: microplastic, strong acid, chemical resistance, polymer, chemical digestion

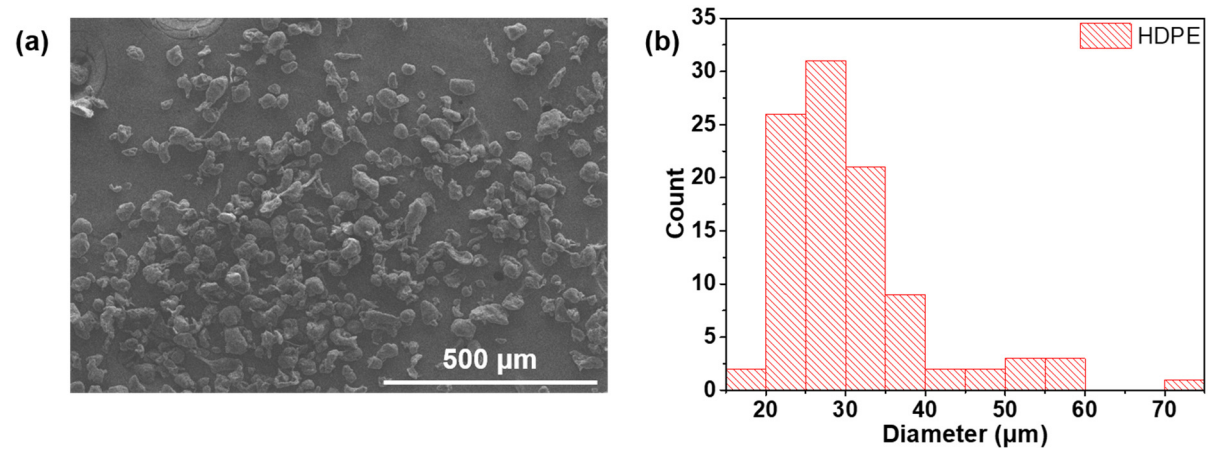


Figure S1. (a) SEM image of the HDPE MP model samples and (b) size-distribution graph.

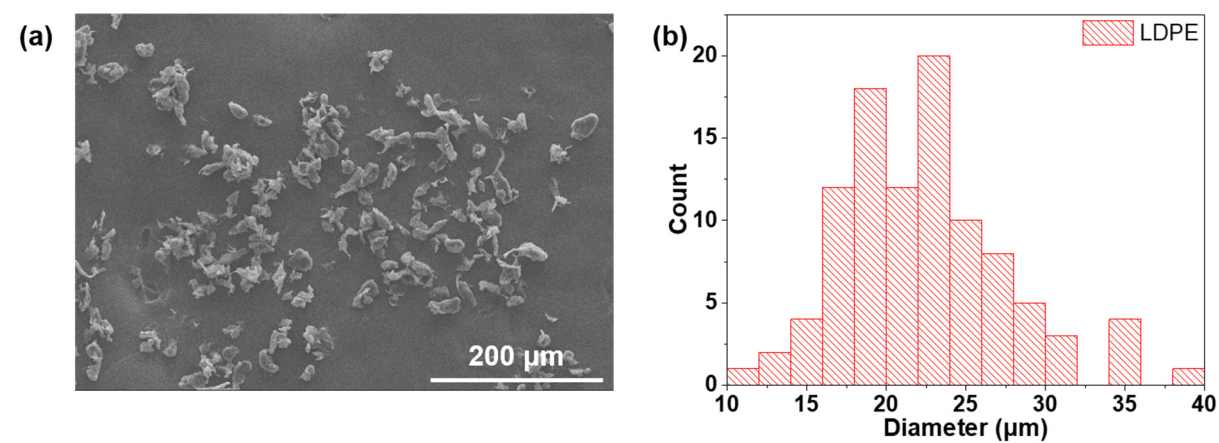


Figure S2. (a) SEM image of the LDPE MP model samples and (b) size-distribution graph.

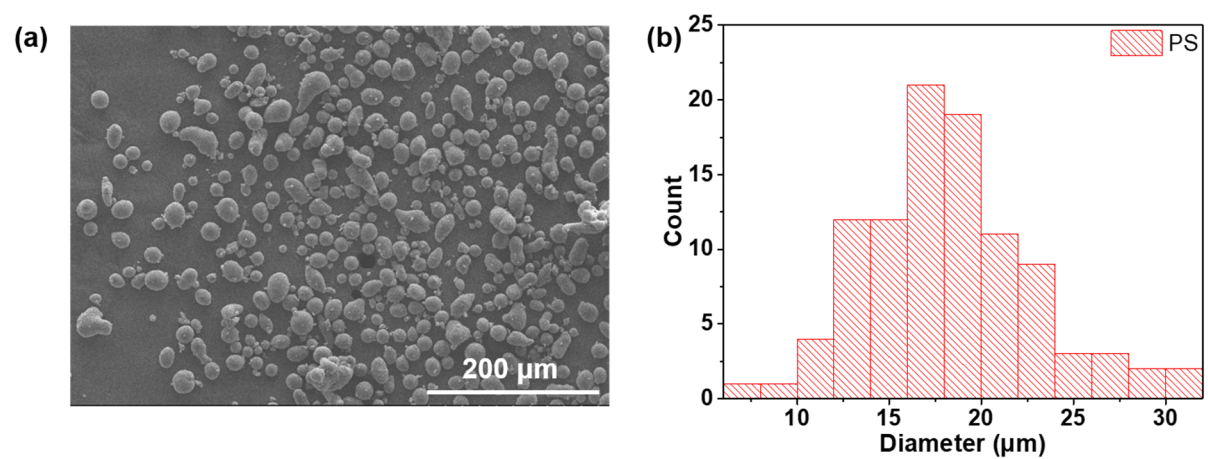


Figure S3. (a) SEM image of the PS MP model samples and (b) size-distribution graph.

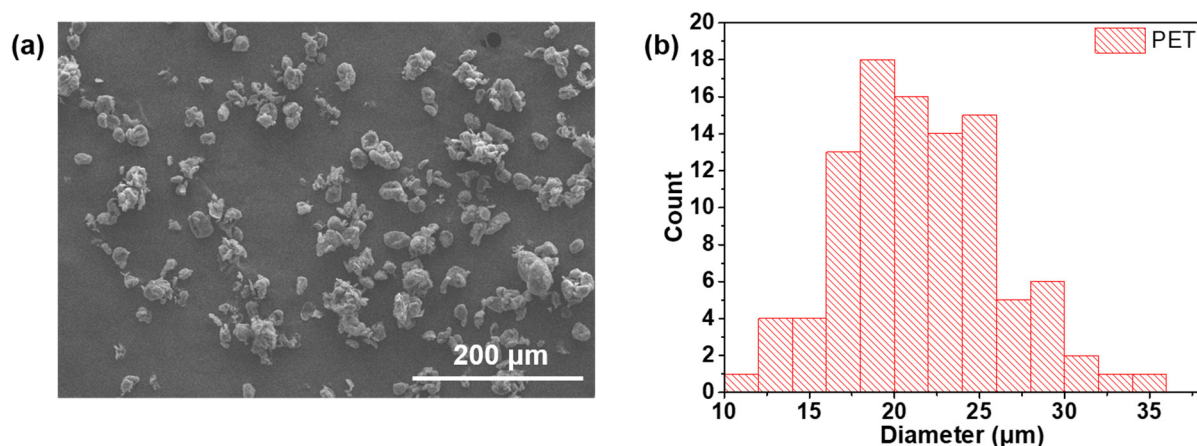


Figure S4. (a) SEM image of the PET MP model samples and (b) size-distribution graph.

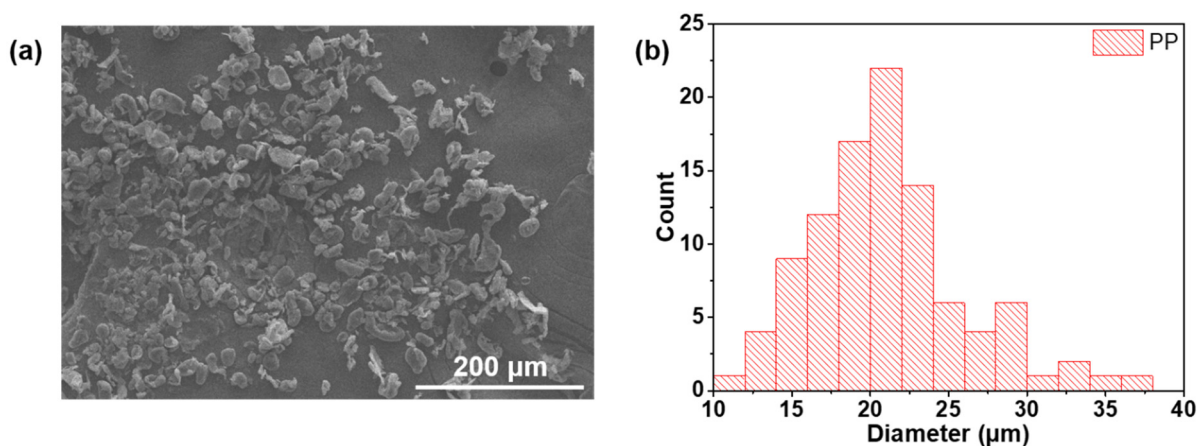


Figure S5. (a) SEM image of the PP MP model samples and (b) size-distribution graph.



Figure S6. Photographs of the HDPE samples in the pristine state, following chemical stability tests against strong acids and alkalis (H_2SO_4 , HCl , H_2O_2 , KOH , and $NaOH$) used in the chemical digestion procedure at (a) 25 °C for 1 d, (b) 70 °C for 1 d, and (c) 25 °C for 7 d.

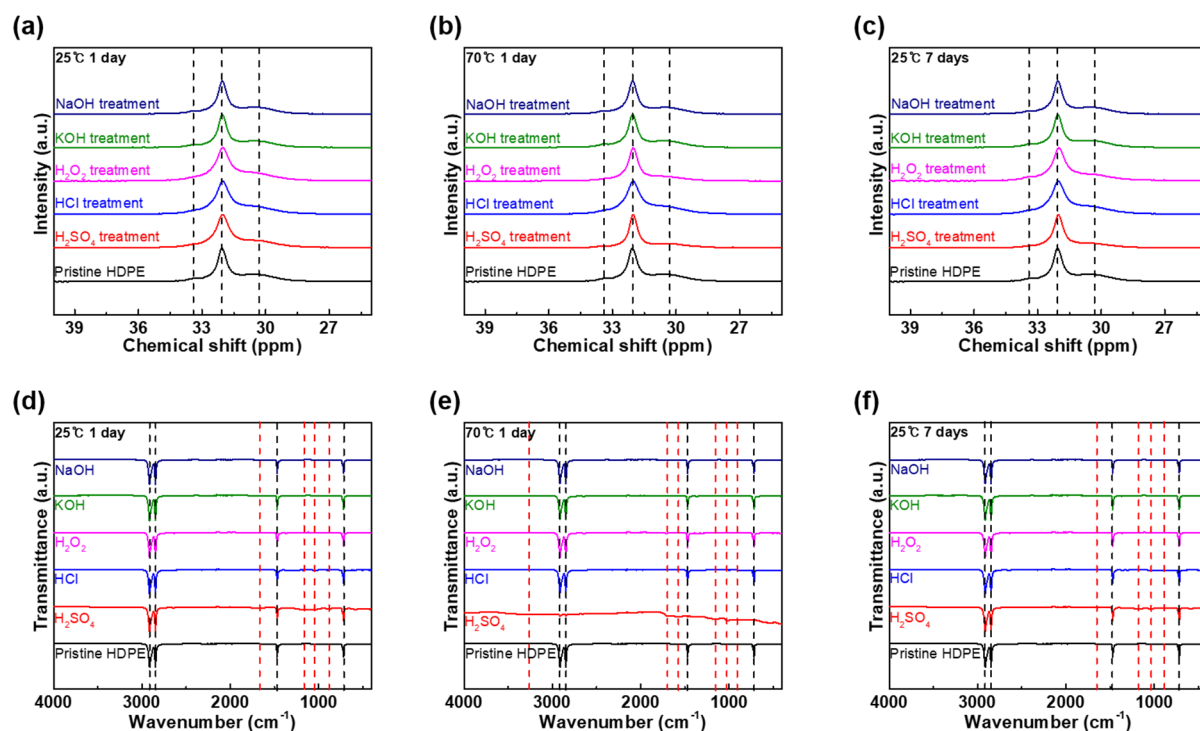


Figure S7. ^{13}C NMR spectra of pristine HDPE and the HDPE samples after reaction with H_2SO_4 , HCl , H_2O_2 , KOH , and NaOH at (a) $25\text{ }^\circ\text{C}$ for 1 d, (b) $70\text{ }^\circ\text{C}$ for 1 d, and (c) $25\text{ }^\circ\text{C}$ for 7 d. FT-IR spectra of pristine HDPE and the HDPE samples after reaction with H_2SO_4 , HCl , H_2O_2 , KOH , and NaOH at (d) $25\text{ }^\circ\text{C}$ for 1 d, (e) $70\text{ }^\circ\text{C}$ for 1 d, and (f) $25\text{ }^\circ\text{C}$ for 7 d.

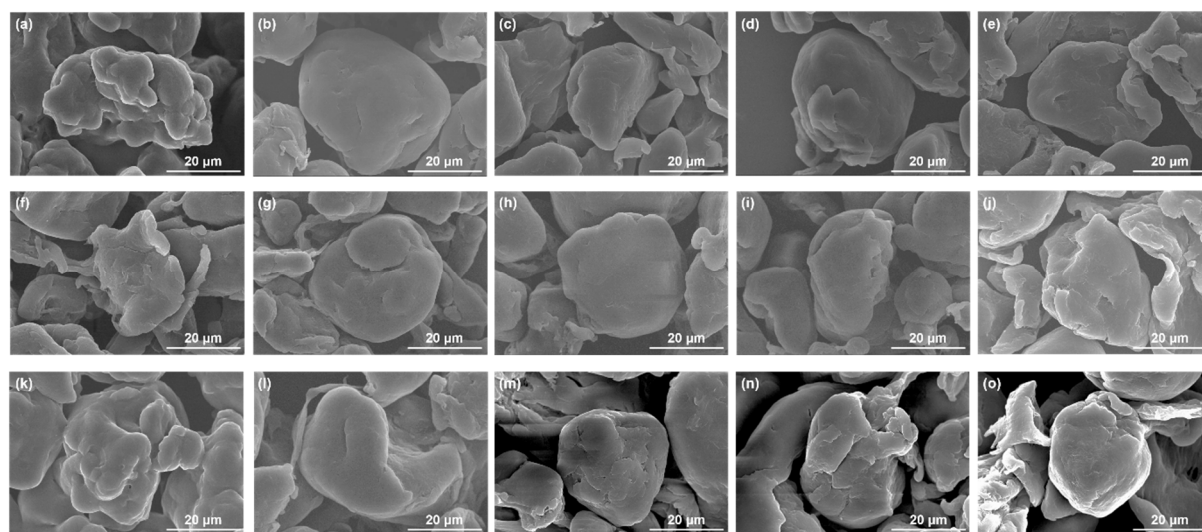


Figure S8. SEM images of the HDPE samples after reaction with (a) H_2SO_4 , (b) HCl , (c) H_2O_2 ,

(d) KOH, and (e) NaOH at 25 °C for 1 d. SEM images of the HDPE samples after reaction with (f) H₂SO₄, (g) HCl, (h) H₂O₂, (i) KOH, and (j) NaOH at 70 °C for 1 d. SEM images of the HDPE samples after reaction with (k) H₂SO₄, (l) HCl, (m) H₂O₂, (n) KOH, and (o) NaOH at 25 °C for 7 d.



Figure S9. Photograph of the LDPE samples in the pristine state and after undergoing chemical stability tests against strong acids and alkalis at (a) 25 °C for 1 d, (b) 70 °C for 1 d, and (c) 25 °C for 7 d.

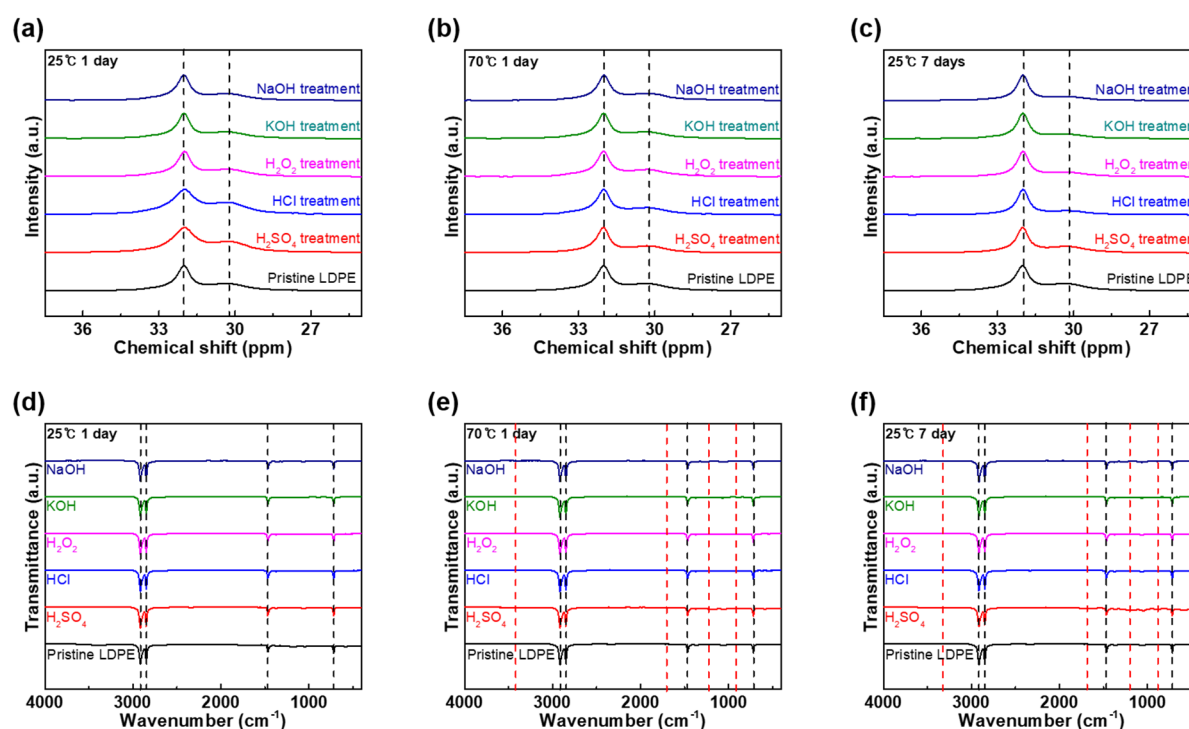


Figure S10. ¹³C NMR spectra of pristine LDPE and the LDPE samples after reaction with H₂SO₄, HCl, H₂O₂, KOH, and NaOH at (a) 25 °C for 1 d, (b) 70 °C for 1 d, and (c) 25 °C for 7 d. FT-IR spectra of pristine LDPE and the LDPE samples after reaction with H₂SO₄, HCl,

H₂O₂, KOH, and NaOH at (d) 25 °C for 1 d, (e) 70 °C for 1 d, and (f) 25 °C for 7 d.

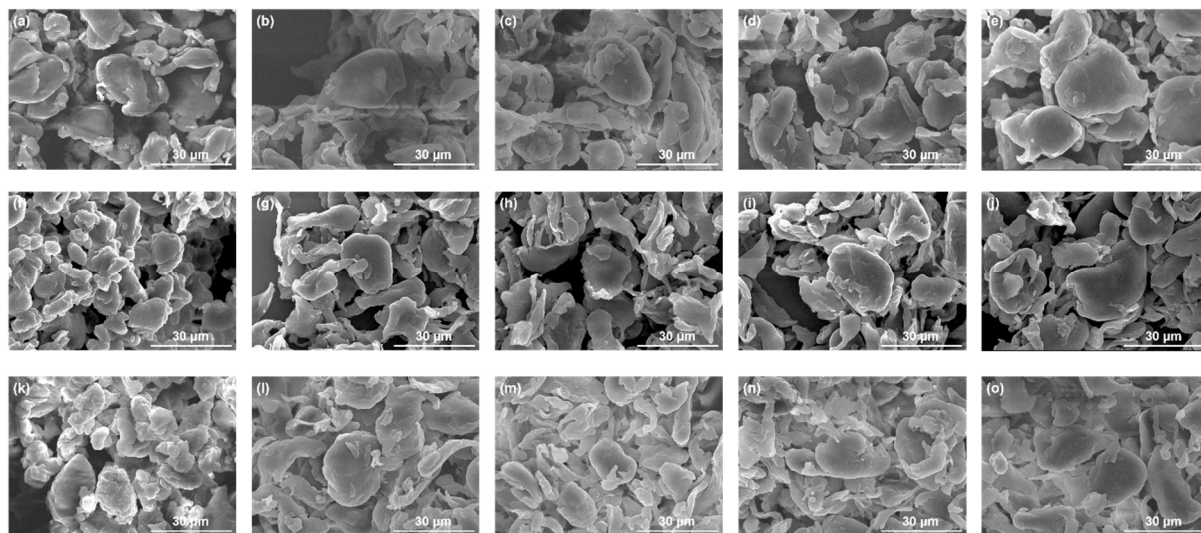


Figure S11. SEM images of the LDPE samples after reaction with (a) H₂SO₄, (b) HCl, (c) H₂O₂, (d) KOH, and (e) NaOH at 25 °C for 1 d. SEM images of the LDPE samples after reaction with (f) H₂SO₄, (g) HCl, (h) H₂O₂, (i) KOH, and (j) NaOH at 70 °C for 1 d. SEM images of LDPE samples after reaction with (k) H₂SO₄, (l) HCl, (m) H₂O₂, (n) KOH, and (o) NaOH at 25 °C for 7 d.



Figure S12. Photograph of the PS samples in the pristine state and after chemical stability tests against strong acids and alkalis at (a) 25 °C for 1 d, (b) 70 °C for 1 d, and (c) 25 °C for 7 d.

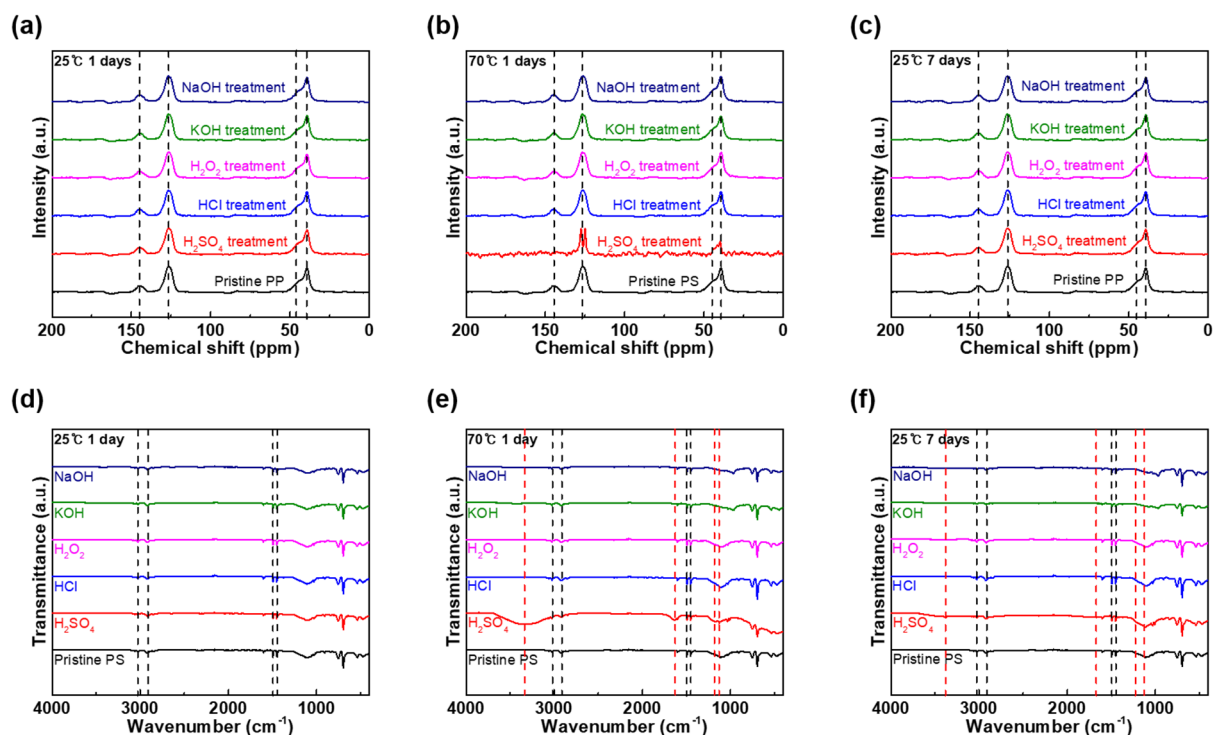


Figure S13. ^{13}C NMR spectra of pristine PS and the PS samples after reaction with H_2SO_4 , HCl, H_2O_2 , KOH, and NaOH at (a) 25 °C for 1 d, (b) 70 °C for 1 d, and (c) 25 °C for 7 d. FT-IR spectra of pristine PS and the PS samples after reaction with H_2SO_4 , HCl, H_2O_2 , KOH, and NaOH at (d) 25 °C for 1 d, (e) 70 °C for 1 d, and (f) 25 °C for 7 d.

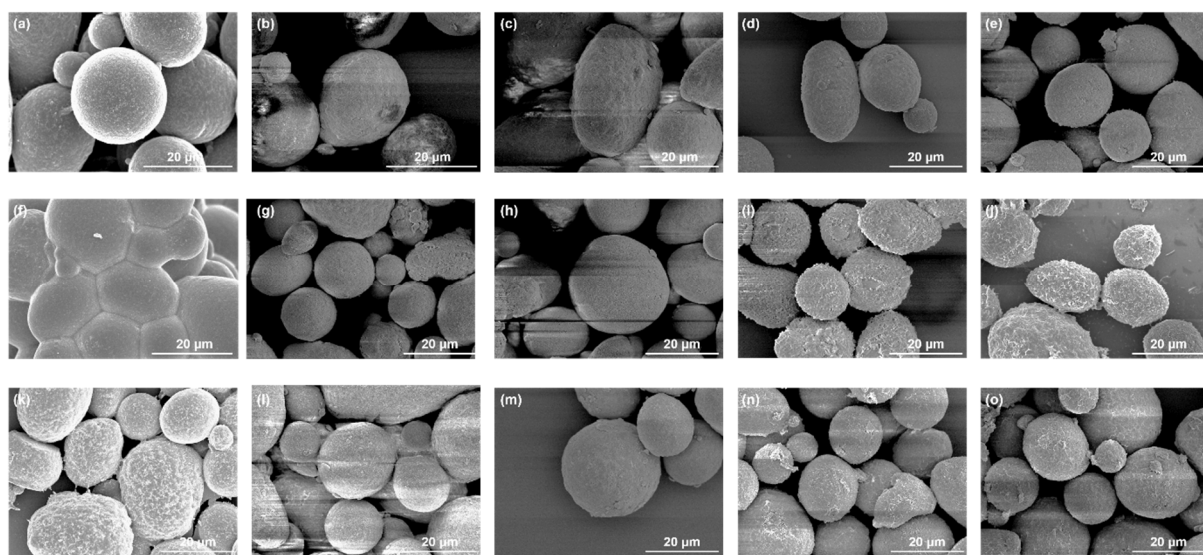


Figure S14. SEM images of the PS samples after reaction with (a) H_2SO_4 , (b) HCl, (c) H_2O_2 , (d) KOH, and (e) NaOH at 25 °C for 1 d. SEM images of the PS samples after reaction with (f)

H₂SO₄, (g) HCl, (h) H₂O₂, (i) KOH, and (j) NaOH at 70 °C for 1 d. SEM images of the PS samples after reaction with (k) H₂SO₄, (l) HCl, (m) H₂O₂, (n) KOH, and (o) NaOH at 25 °C for 7 d.

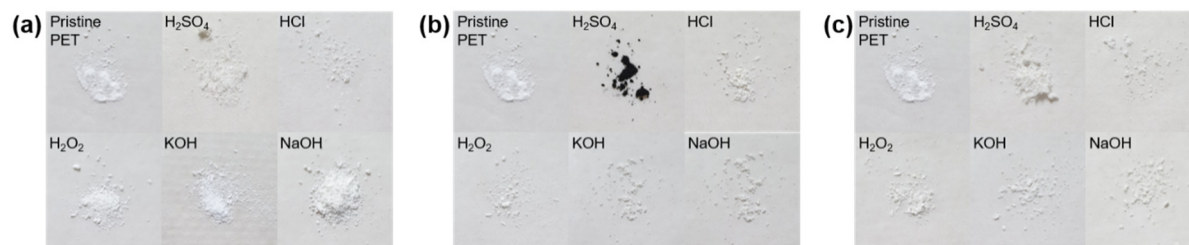


Figure S15. Photograph of the PET samples in the pristine state and after chemical stability tests against strong acids and alkalis at (a) 25 °C for 1 d, (b) 70 °C for 1 d, and (c) 25 °C for 7 d.

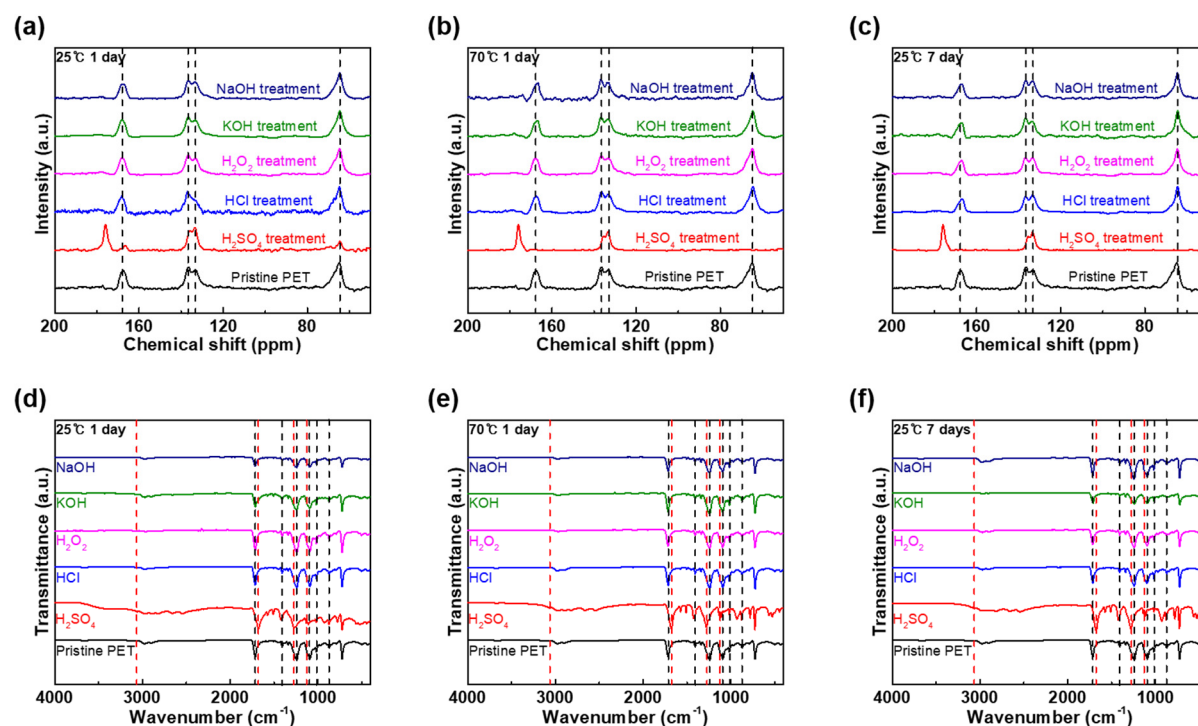


Figure S16. ¹³C NMR spectra of pristine PET and the PET samples after reaction with H₂SO₄, HCl, H₂O₂, KOH, and NaOH at (a) 25 °C for 1 d, (b) 70 °C for 1 d, and (c) 25 °C for 7 d. FT-IR spectra of pristine PET and the PET samples after reaction with H₂SO₄, HCl, H₂O₂, KOH, and NaOH at (d) 25 °C for 1 d, (e) 70 °C for 1 d, and (f) 25 °C for 7 d.

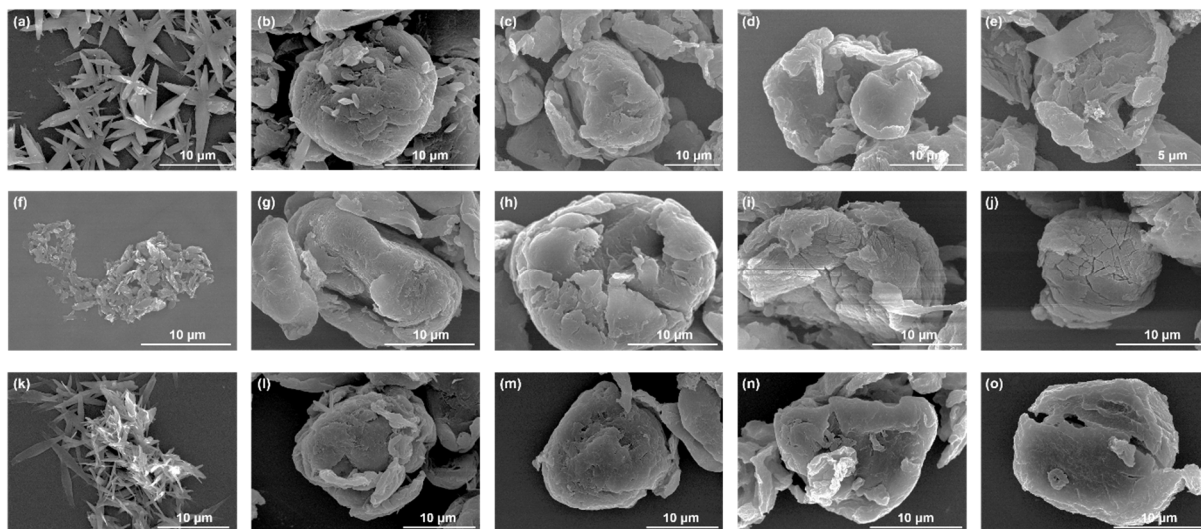


Figure S17. SEM images of the PET samples after reaction with (a) H_2SO_4 , (b) HCl , (c) H_2O_2 , (d) KOH , and (e) NaOH at 25 °C for 1 d. SEM images of the PET samples after reaction with (f) H_2SO_4 , (g) HCl , (h) H_2O_2 , (i) KOH , and (j) NaOH at 70 °C for 1 d. SEM images of the PET samples after reaction with (k) H_2SO_4 , (l) HCl , (m) H_2O_2 , (n) KOH , and (o) NaOH at 25 °C for 7 d.



Figure S18. Photograph of the PP samples in the pristine state and after chemical stability tests against strong acids and alkalis at (a) 25 °C for 1 d, (b) 70 °C for 1 d, and (c) 25 °C for 7 d.

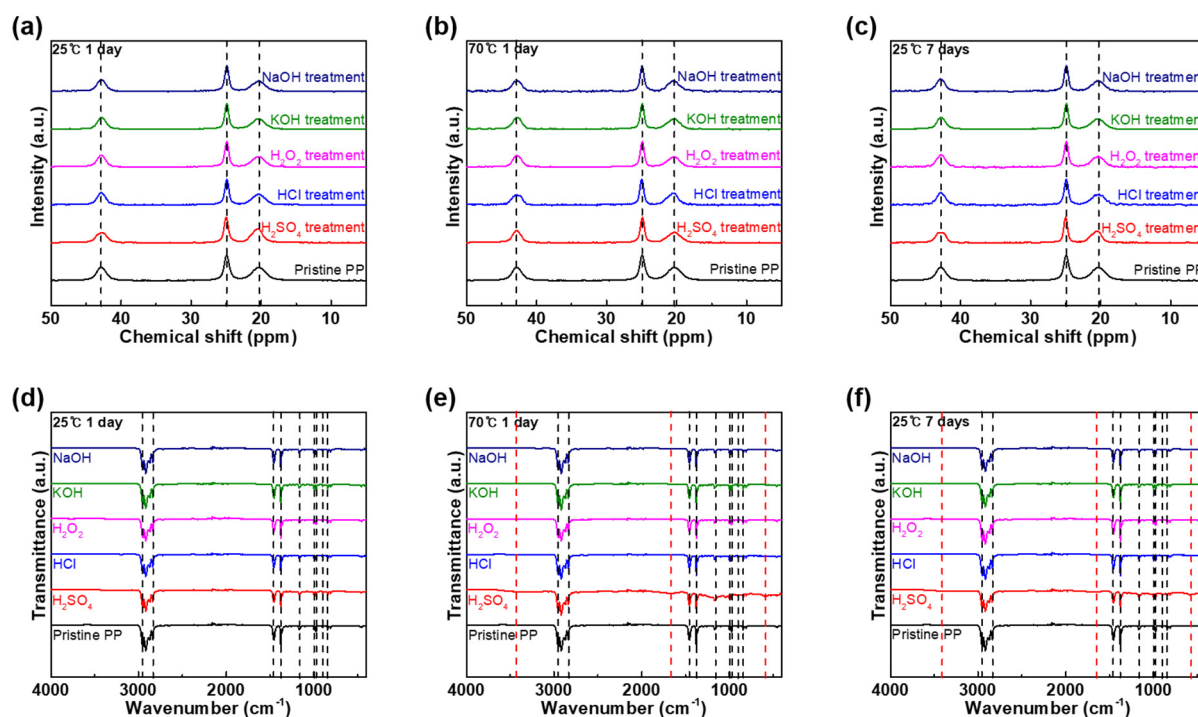


Figure S19. ^{13}C NMR spectra of pristine PP and the PP samples after reaction with H_2SO_4 , HCl , H_2O_2 , KOH , and NaOH at (a) 25°C for 1 d, (b) 70°C for 1 d, and (c) 25°C for 7 d. FT-IR spectra of pristine PP and the PP samples after reaction with H_2SO_4 , HCl , H_2O_2 , KOH , and NaOH at (d) 25°C for 1 d, (e) 70°C for 1 d, and (f) 25°C for 7 d.

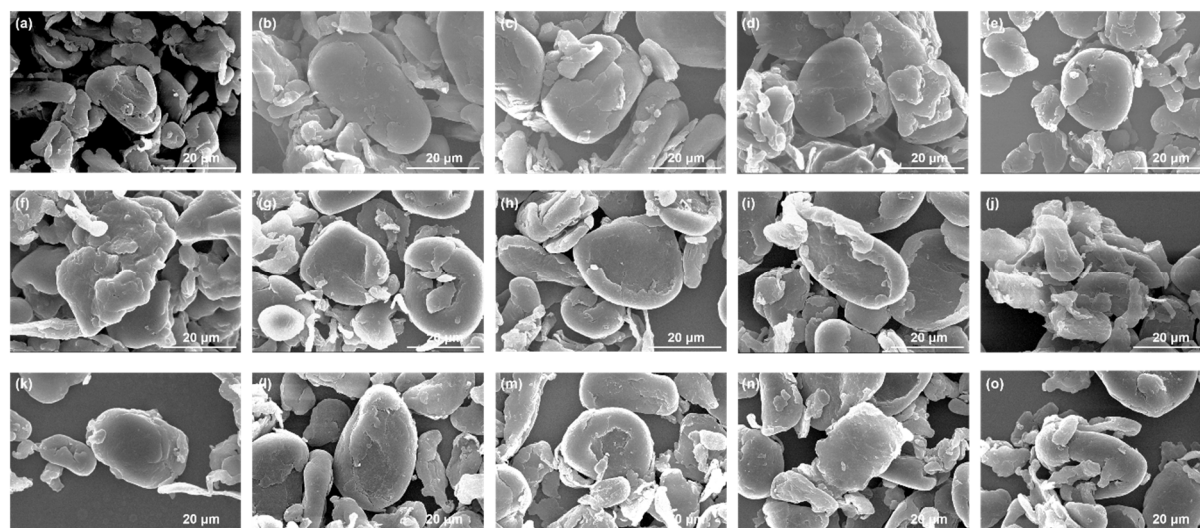


Figure S20. SEM images of the PP samples after reaction with (a) H_2SO_4 , (b) HCl , (c) H_2O_2 , (d) KOH , and (e) NaOH at 25°C for 1 d. SEM images of the PP samples after reaction with (f) H_2SO_4 , (g) HCl , (h) H_2O_2 , (i) KOH , and (j) NaOH at 70°C for 1 d. SEM images of the PP

samples after reaction with (k) H_2SO_4 , (l) HCl , (m) H_2O_2 , (n) KOH , and (o) NaOH at 25 °C for 7 d.