**Supporting information**

**Text S1.** Synthesis of PCEs with different side chain lengths and different densities carboxylate groups.

**Text S2.** Synthesis and characterization of newly copolymer N.

**Table S1.** Molar ratios of monomers of the synthesized SPs.

**Figure S1.** Chemical structure of the AA-APEG type PCEs.

**Figure S2.** Spread flow of cement pastes containing different dosages of SPs as prepared, (a) series of APEG10; (b) series of APEG23; (c) series of APEG35; (d) series of APEG52. (cement, P. I42.5R, w/c = 0.29).

**Figure S3.** (a) Spread flow of cement pastes; (b) Cement paste fluidity over time; (c) Spread flow of cement pastes containing synthesized copolymer measured in the presence of different clay contents by weight of cement bwoc.

**Figure S4.** Synthetic route of the monomer N.

**Figure S5.** (a) FTIR of new monomer; (b) 1H NMR of new monomer. N represented new copolymer monomer.

**Figure S6.** (a) Spread flow of cement pastes mixed with SPs of different monomer N content; (b) Spread flow of cement pastes containing 0.3 % bwoc SPs measured in the presence of 1 % bwoc of montmorillonite.

**Figure S7.** Adsorption kinetics of APEG10-3 and APEG10-3-N onto cement suspension at a given content of 0.3 % (weight percent ratio of solid content to cement).

**Figure S8.** Test for fluorescence of cement powder mixed with APEG10-3 and APEG10-3-N at a given content of 0.3 % (weight percent ratio of solid content to cement).

**Text S1.** Synthesis of PCEs with different side chain lengths and different densities carboxylate groups.

A five-neck, round-bottom flask equipped with a thermometer and a magnetic stirrer, was charged with distilled water, AA and chain transfer agent heated to 70 oC with stirring under nitrogen. Subsequently, Several APEG and the initiator solution were added separately at constant flow rates over a period of 2.0 h. The reaction mixture was heated to 80 oC and maintained at this temperature for a further 1.5 h, NaOH solution with mass concentration of 30.0 % was used to adjust the pH value of the product to about 7, to ultimately afford an aqueous copolymer solution containing approximately 30 % solid.

**Text S2.** Synthesis and characterization of newly copolymer N.

S2.1. Synthesis of N-1

5.54 g (0.02 mol) 4- bromine -1, 8- naphthalene two anhydride was added to a three-necked flask and then added 60 mL absolute ethyl alcohol. And stirred the solution, in the meanwhile slowly heated it. Then 12 mL (0.02 mol) ethanolamine was added to the compound and reacted under the condition of refluxing 1-2 h, and used silica gel TCL to confirm whether the reaction was finished. If it was finished, filtered the solution while it was hot, refrigerated the filtrate and then filtrated so that we can get coarse compound 2. After vacuum drying and recrystallization by absolute ethyl alcohol, we can get some orange-yellow crystal samples, the purpose of this procedure is for the next reaction to proceed smoothly.

S2.2. Synthesis of N-2

3.2 g (0.01mol) of the compound 2 was added to a three-necked flask and then added 30 mL ethylene glycol monomethyl. Then heated it make compound 2 fully dissolved. Next 3.3 mL (0.03 mol) N-methyl-1-piperazinylallyl was added to the compound and reacted under the condition of refluxing 5-6 h and used silica gel TCL to confirm whether the reaction was finished. After the reaction was completed, removed solvent under vacuum by distillation and added 10mL absolute ethyl ethanol. Next after the compound fully refrigerated. By means of filtering and vacuum drying, we can get yellow-green solid 3.

S2.3. Synthesis of N

3.4 g (0.01 mol) of the solid 3 was added to a three-necked flask and then added 40 mL acetone solvent, next 3.85 g (0.05 mol) allyl chloride was added. After heating and stirring for a period of 8 -10 h under the condition of refluxing. Removal of solvent by vacuum distillation and then added 50 mL deionized water to the solution. After shocking for 0.5 h continually and filtered, we got filter liquor. Then, the filter solvent was removed by vacuum distillation and dried it under vacuum. After recrystallization by acetone, we finally got yellow-green solid 4, which was the final monomer.

S2.4. Characterization of the new monomer

In the FTIR analysis, [double bond](http://www.so.com/link?url=http%3A%2F%2Fdict.youdao.com%2Fsearch%3Fq%3D%255B%25E7%2589%25A9%25E5%258C%2596%255D%2520double%2520bond%26keyfrom%3Dhao360&q=%E5%8F%8C%E9%94%AE%E7%BF%BB%E8%AF%91&ts=1505657590&t=4d97962a89dc826a521352139c828bc) of the new monomer stretch vibration gives rise to a broad band near 1657 cm-1. For the-C-Br- and -CH3 bend bands are near 784 cm-1 and 1398 cm-1. The H peaks of new monomer also being consistent with its structure. These peaks are at (ppm) 3.14 (H4), 3.48 (H5), 3.65 (H6), 3.93 (H9), 4.08(H3), 5.7 (H1), 6.05 (H2), 6.02 (H7), and 8.07 (H8). The results of FTIR and 1H NMR analyses confirmed that the new monomer were synthesized as designed.

**Table S1.** Molar ratios of monomers of the synthesized SPs.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| APEG10  (MW 500) | Molar ratio  (AA:APEG) | APEG23  (MW 1000) | Molar ratio  (AA:APEG) | APEG35  (MW 1500) | Molar ratio  (AA:APEG) | APEG52  (MW 2400) | Molar ratio  (AA:APEG) |
| APEG10-3 | 3 | APEG23-3 | 3 | APEG35-3 | 3 | APEG52-3 | 3 |
| APEG10-5 | 5 | APEG23-5 | 5 | APEG35-5 | 5 | APEG52-5 | 5 |
| APEG10-10 | 10 | APEG23-10 | 10 | APEG35-10 | 10 | APEG52-10 | 10 |
| APEG10-15 | 15 | APEG23-15 | 15 | APEG35-15 | 15 | APEG52-15 | 15 |

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**Figure S1.** Chemical structure of the AA-APEG type PCEs.

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**Figure S2.** Spread flow of cement pastes containing different dosages of SPs as prepared, (a) series of APEG10; (b) series of APEG23; (c) series of APEG35; (d) series of APEG52. (cement, P. I42.5R, w/c = 0.29).

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**Figure S3.** (a) Spread flow of cement pastes; (b) Cement paste fluidity over time; (c) Spread flow of cement pastes containing synthesized copolymer measured in the presence of different clay contents by weight of cement (bwoc).

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**Figure S4.** Synthetic route of the monomer N.

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**Figure S5.** (a) FTIR of new monomer; (b) 1H NMR of new monomer. N represented new copolymer monomer.

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**Figure S6.** (a) Spread flow of cement pastes mixed with SPs of different monomer N content; (b) Spread flow of cement pastes containing 0.3 % bwoc SPs measured in the presence of 1 % bwoc of montmorillonite.

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**Figure S7.** Adsorption kinetics of APEG10-3 and APEG10-3-N onto cement suspension at a given content of 0.3 % (weight percent ratio of solid content to cement).

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**Figure S8.** Test for fluorescence of cement powder mixed with APEG10-3 and APEG10-3-N at a given content of 0.3 % (weight percent ratio of solid content to cement).