

SELF-HEALING COATINGS FOR CONCRETE PROTECTION

Young-Kyu Song¹, Ye-Hyun Jo¹, Ye-Ji Lim¹, Hwan-Chul Yu¹, Byung-Cheol Ryu², Sang In Lee²
and Chan-Moon Chung¹

¹Department of Chemistry, Yonsei University
234 Maeji-ri, Heungup-myun, Wounju-si, Gangwon-do 220-710, Korea
Email: ssong-a@yonsei.ac.kr

²Korea Conformity Laboratory
1276 Jisa-dong, Kangseo-ku, Busan, 618-230, Korea
Email: rbc@kcl.re.kr

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ABSTRACT

Many approaches to protecting concrete surface from various deterioration factors have been studied. A typical approach is to use protective coatings. However, when cracks form and propagate in protective coatings for concrete, chloride ion, carbon dioxide and water would penetrate through the cracks, resulting in reduction in serviceability of concrete. If the protective coatings have self-healing ability they can effectively protect the concrete surface from the deterioration factors [1]. In this work we have developed self-healing protective coatings for concrete surface in which cracks formed can be healed by light.

A cinnamide-type siloxane oligomer as a photochemical healing agent was readily synthesized by reaction of cinnamoyl chloride with an amino-containing siloxane compound, and its structure was confirmed by proton nuclear magnetic resonance (¹H NMR) spectroscopy. The healing agent was obtained as a viscous oil. A methacrylate-type siloxane compound was purchased and also used as a photochemical healing agent.

Photoreaction behaviour of the healing agents was investigated by photoirradiation with a xenon lamp. It was confirmed by infrared (IR) spectroscopy that cinnamide-type siloxane underwent [2+2] cycloaddition upon photoirradiation [2]. The siloxane methacrylate afforded a crosslinked polymer by photoirradiation in the presence of a radical photoinitiator.

We have performed microencapsulation of the healing agents using poly(urea-formaldehyde) as shell material. The formation of microcapsules was confirmed by IR spectroscopy, and capsule characteristics were studied by optical microscopy and scanning electron microscopy (SEM).

The microencapsulated photoreactive siloxanes were dispersed into a coating solution to prepare protective coating formulations, which were coated on concrete. Upon damage-induced cracking, the microcapsules were ruptured by the propagating crack fronts, resulting in release of the healing agent into the crack by capillary action (Figure 1). Self-healing of the cracks was attempted by photochemical crosslinking of the healing agent.

It was demonstrated that the cracks were successfully healed, based on optical microscopy, water absorption test, water permeability test and chloride ion penetration test (Figure 2).

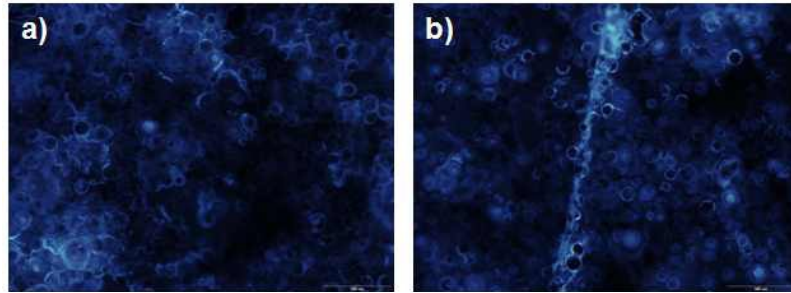


Figure 1: Microscope images of the protective coatings containing microcapsules coated on concrete: (a) before and (b) after crack formation.

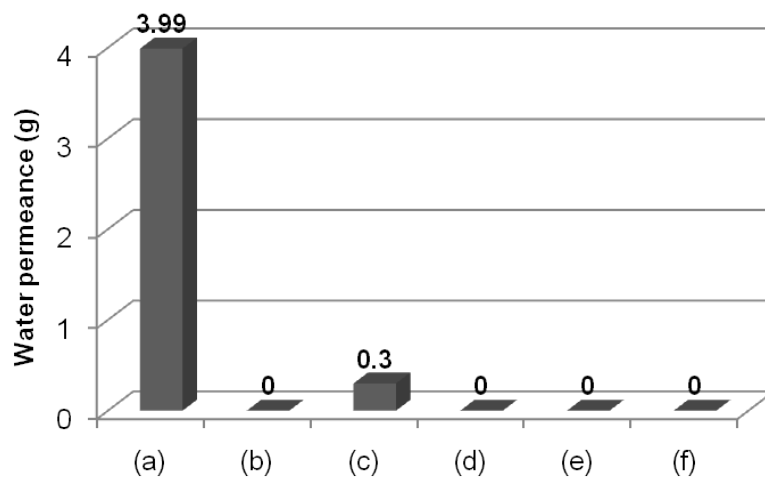


Figure 2: Results of water permeability test for (a) plain concrete, (b) a coating without microcapsules, (c) a cracked coating without microcapsules, (d) a healing agent only, (e) a coating containing microcapsules and (f) a cracked coating containing microcapsules which was healed by photoirradiation.

REFERENCES

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