질산 처리 후 산화된 MWCNT를 혼입한 시멘트 페이스트의 성능

Performance of Cement Paste Incorporating Oxidized MWCNT after Nitro-Sulfuric Acid treatment

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Abstract

Recently, the utilization of carbon nanotubes (CNT) in cement paste has been widely investigated in terms of improving the dispersion quality and enhancing the cement paste mechanical performance. While methods of functionalizing the CNT using surfactants to disperse the nanoparticles have been studied to some extent, the literature on the effects of chemical covalent functionalization is still scarce. This work focuses on chemical functionalization of multiwall carbon nanotubes (MWCNT) using acid treatment, and a consequent addition of the modified MWCNT to the cement paste. The microstructural observation and degree of the MWCNT functionalization are examined using FE-SEM. The compressive strength is measured at an age of 28 days. The results of the study suggest that the acid-functionalized MWCNT are dispersed better compared to the pristine MWCNT due to presence of functional groups. The better dispersion of the nanotubes and the attached functional groups may contribute to the refinement of the microstructure of the cement paste and hence, increase its mechanical strength.

키 워 드 : 시멘트 페이스트, 탄소나노튜브, 탄소나노튜브 기능화, 역학적 강도
Keywords : cement paste, carbon nanotubes, CNT functionalization, mechanical strength

1. Introduction

Carbon nanotube (CNT) utilization in cement composites has significant potential for improving the mechanical performance since the CNTs possess exceptional physical properties such as tensile strength and elastic modulus which exceed the respective steel properties 10 times. Proper application of the CNT in cement requires good dispersion of the nanoparticles within the cement matrix in order to avoid the defects that may occur from agglomeration of the material due to strong Van der Waals attractive forces. Some methods include physical separation of the carbon nanotubes and chemical functionalization by using surfactants which introduce non-covalent polar electric charges between the nanoparticles and detach them from each other. One more approach for chemical functionalization implies covalent attachment of different functional groups to the surface of the CNT which similarly results in electric charges introduction to separate the agglomerates. In this study, multi-wall carbon nanotubes (MWCNT) are functionalized using nitric and sulfuric acids, and finally added to the cement paste.

2. Experimental methods

2.1 Materials

MWCNT Jenotube 10A with purity 97.5% was provided by JEIO Co., Ltd., Incheon. Sulfuric (H_2SO_4) and Nitric (HNO_3) acids, purchased from Sigma-Aldrich Co., Ltd., USA. Cement Type I used in the project was received from Asia Cement Co., Ltd., Seoul. Polycarboxylate ether (PCE) used as a surfactant for dispersion was obtained

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2.2 Experimental procedure

The MWCNT were placed into a mix of sulfuric and nitric acid in a ratio of 3:1. The mixture was placed into an ultrasonic bath and sonicated for 6 hours, filtered and dried. The cement paste samples were cast using w/c ratio 0.3 and MWCNT content was set to 0.1 wt.% by cement. In order to disperse the nanotubes prior to cement paste mixing, the amount of PCE was added in a ratio of 1:1 with respect to MWCNT. The functionalization degree of the MWCNT was estimated and the mechanical strength of the cement paste was tested.

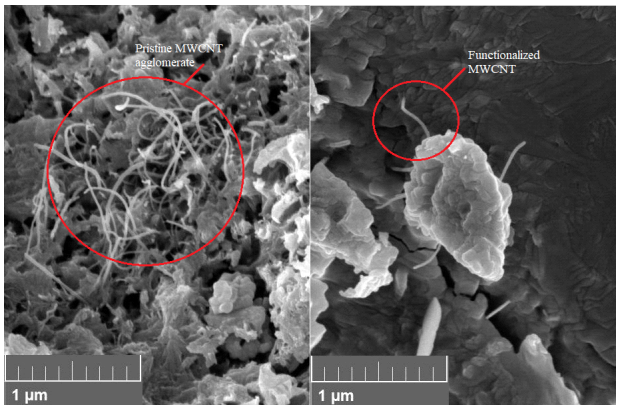

Figure 1. FE-SEM image of the pristine MWCNT and functionalized MWCNT in cement paste

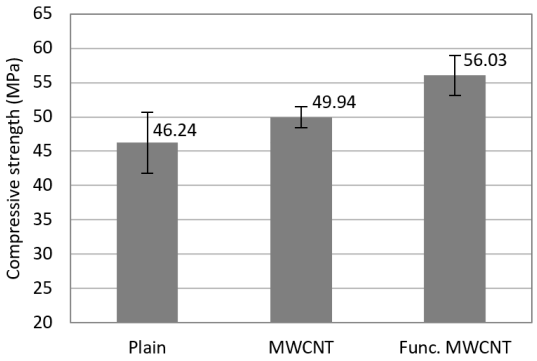

Figure 2. Compressive strength of cement paste at 28 days

3. Conclusion

The introduction of acid functionalized MWCNT into cement paste leads to a better dispersion of the MWCNT within the cement matrix. The FE-SEM imaging showed a larger amount of disentangled MWCNT in cement which in turn refines the microstructure and leads to an increased density of cement paste samples. As a result, this may be the reason for higher mechanical strength of the cement paste incorporating functionalized MWCNT.

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