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The influence of AC and DC measurements on electrical resistance and piezoresistivity of CNTs/cement composites

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Adding Carbon Nanotubes (CNTs) to the cement matrix, the electrical resistance of the composite material decreases. Moreover, the CNTs network inside the cement matrix gives piezoresistive properties to the cementitious material consisting in a variation of the electrical resistance proportional to the level of the stress applied on the concrete structural element. Therefore, cement composites reinforced with CNTs can be used as a sensor to monitor the stress in the structures, to control volume and type of road traffic, to check the access to buildings and to switch on and off the lighting, heating and cooling systems for house automation. In this paper data on electrical resistance on unloaded condition and pressure-sensitive behaviour under different levels of compressive stress of cement paste specimens containing different percentages (0.1%, 0.25%, 0.50% and 1.0% vs. cement mass) of multi-walled carbon nanotubes are presented. In order to form a conductive network and enhance the piezoresistive properties of cementitious mixtures, CNTs were dispersed by using a surfactant. AC and DC measurements of electrical characteristics of multi-walled carbon nanotube/cement composites unloaded or subjected to compressive stress were investigated by using two-probe configuration. Experimental results of DC test were affected by the electrode polarization. The polarization effect of electrodes induced an increase of the electrical resistivity of CNTs cement pastes. Therefore, DC method requires a pre-power time to let electrical resistance reach a stable value. Moreover, to try to limit the polarization effects, alternate current (AC) impedance was adopted. The electrical measurements were carried out in a frequency range of 1– 20000Hz and with a voltage of 100mV. The AC-impedance permits to evaluate the resistance and capacitance characteristics separately. The higher the frequency, the lower the capacitance and, consequently, the polarization effect. At 20000Hz, the electrical resistance of the specimens was evaluated under repeated compressive load cycles (the stress applied was equal to 10% vs. compressive strength of the composite material). The AC measurement can eliminate the effect of capacitor charging and discharging on the pressure sensitive responses of MWNT/cement composites.

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