

The influence of electrode type/set-up and frequency in AC measurements of electrical resistance and piezoresistivity of CNTs reinforced cementitious composites.

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Electrical resistivity of cementitious composites reinforced with Carbon Nanotubes (CNTs) is based on: a) the electrical resistance of composite material itself, b) the electrode resistance and c) the "contact" resistance at the interface electrodes/cement matrix. The electrode resistance is negligible, consequently the actual electrical resistivity of the composite material is the difference between the "measured value" and the "contact" resistance. In order to evaluate the contact resistance an experimental program was carried out to measure the electrical properties of CNTs composites at different frequencies by using two- and four-probe configurations. The electrical resistance on unloaded condition and pressure-sensitive behavior 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 were evaluated. In order to form a conductive network and enhance the piezoresistive properties of cementitious mixtures, CNTs were dispersed by using a surfactant.

At low frequencies (similar to those of a DC) the electrical resistance measured with the two-probe configuration was about three order of magnitude higher than that evaluated by means of the four-probe set-up, independently of the CNTs dosage. This can be attributed to the fact that the four-probe set-up permits to eliminate the contact resistance. On the contrary at high frequencies the electrical resistance value are similar independently of the configuration adopted. At high frequencies, in fact, the AC measurements eliminate the effect of capacitor charging and discharging on the pressure-sensitive responses of MWNT/cement composites.

		Paste_0.1%	Paste_0.25%	Paste_0.5%	Paste_1.0%
Water	kg/m ³	642	643	644	640
Cement	kg/m ³	1082	1074	1068	1078
w/c ratio		0.6	0.6	0.6	0.6
CNTs	kg/m ³	1.1	2.7	5.3	10.9
	% vs cm	0.10%	0.25%	0.50%	1.0%
LAS	kg/m ³	11	11	11	11
	% vs cm	1.0%	1.0%	1.0%	1.0%
TBP	kg/m ³	2	2	2	2
	% vs cm	0.2%	0.2%	0.2%	0.2%
VM _{estimated}	kg/m ³	1738	1733	1730	1742
VM _{measured}	kg/m ³	1725	1690	1732	1717
Variation	%	-0.8%	-2.5%	0.1%	-1.4%