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ACTUATED TENSILE TESTING OF CNT BASED ARCHITECTURES

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Summary: Actuators serving both characteristics, to be flexible and stiff enough to bear mechanical loading are a strong research desire with endless application possibilities. Current suffer from low or unstable mechanical properties. That is why these actuators are additionally fixed on structures which they have to deform. In passive status the actuators represent additional weight. But nanoscale carbon tubes (CNTs) show promising electro-mechanical properties to overcome these disadvantages. Young's modulus of 640GPa and comparable high active strains of 1% seem to fulfill the requirements of a structural actuator. At first paper-like architectures made of CNTs are tested in capacitor mode, two electrodes with an electrically insulating but ionically conductive electrolyte in between. An in-plain strain of the electrodes can be detected. However, the actuation-mechanism is still unknown. Different experiments point out different physical effects, ranging from electrostatic effects to quantum-mechanical effects. Actually it seems that the found results are a matter of the specimen, its composition and the type of experiment. The presented paper focuses to the results found during actuated tensile-tests addressing dependencies between specimen composition and possible physical effect. Architectures made of single walled CNTs, also called CNT-papers and multi walled CNT-arrays, which feature single, continuous CNTs in one dimension, are compared. The tensile tests are conducted in dry, wet and wet/actuated condition to determine swelling-effects. Furthermore tensile tests were conducted at different actuation potentials to identify an electrostatic effect. It can be found that CNT-papers strongly depend mechanically on the conditions. The Young's modulus falls by 40%. In actuated status it is not as significant. While this trend continues at positive potentials it's vice versa at negatives. This might be an effect of the ions but points out a mechanical dependency to the charging. In contrast CNT-arrays reveal no significant difference under various conditions. In terms of complete wetting CNT-arrays require ionic liquids due to their hydrophobic character while CNT-papers were tested in an aqueous NaCl-solution. However, an active response can only be detected at negative potentials. Due to the experimental set-up and specimen composition a quantum-mechanical effect seem to be a very probable reason for actuation.