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#10-64 Fast neutron detector based on vertically aligned carbon nanotubes

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The unique physical properties of carbon nanotubes have spurred numerous applications across various fields. In this study, we investigate their electrical properties to develop a detector for fast neutron flux measurement. Previous research has demonstrated their potential in dosimetry for thermal neutrons and gamma radiation using random networks of carbon nanotubes.

For the measurement of fast neutron flux, we utilize vertically aligned multi-walled carbon nanotubes and monitor the changes in their electrical resistivity under neutron irradiation using a four-probe technique. The vacancies generated in the nanotube structures due to irradiation directly affect their electrical properties, allowing us to deduce the neutron flux from variations in resistivity.

Future fusion reactors, such as ITER, are expected to generate intense neutron fluxes in high-temperature environments. These fluxes are challenging for traditional detectors, which tend to degrade quickly under such conditions. Carbon nanotube carpets, with their low density, reduce the number of interactions caused by neutron irradiation, thereby extending the device's operational lifetime. Additionally, the thermal properties of carbon nanotubes make them well-suited for high-temperature environments like fusion reactors. Furthermore, the low production cost of these detectors presents a compelling case for their development.

In this work, we present the development of our prototype, starting with a description of the material and dimensions of the nanotubes. We also detail the results of simulations performed using Geant4, which provide valuable insights into reaction rates and the spatial distribution of defects within the device. These simulations allow us to make informed predictions about the detector's behavior under irradiation. While the precise evolution of the device's electrical resistance cannot be fully simulated, it can be approximated by treating each nanotube as a parallel resistor. Defects in the nanotube structure increase its electrical resistance, enabling us to estimate the device's electrical resistance change during irradiation.

The next phase involves building a prototype, where we will outline the construction process and present the first test results of these initial prototypes.

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