INTERACTION OF IONIZING RADIATION WITH DNA NANOSTRUCTURES

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Abstract. Understanding the mechanisms of DNA damage by ionizing radiation is crucial in optimizing current radiotherapeutic modalities against cancer. Investigations span a broad scale from gas phase studies on electron-induced damage to DNA subunits, to irradiation studies of cell cultures and organisms. Damage to irradiated DNA subunits often cannot fully explain observed damages on the biological scale prompting studies at various levels of complexity in between. Here, we use DNA origami nanostructures as a platform to explore processes in the intermediate (nanoscale) dimensions. These self-assembling nanostructures are formed from folding single-stranded DNA scaffolds using short complementary oligomers (staples). The staples provide functionalizable ends so DNA sequences of interest or probes can be attached. They can then be closely studied by conventional microscopy techniques like atomic force microscopy (AFM). To explore the potential of such nanostructures as stable platforms for irradiation studies in solution, we subject them to various types of ionizing radiation from gamma rays (~1.2 MeV) to proton beams (30 MeV) to high-energy electrons (16 MeV). We observe structural stability even up to kGy doses. We also irradiate DNA origami nanoframes anchoring different types of sequences to study radiosensitization by halogenated nucleosides. Eventually, we plan to expose these systems to ion beams which could lead to some insights into mechanisms of DNA damage and radiosensitization for the improvement of ion beam radiotherapy.

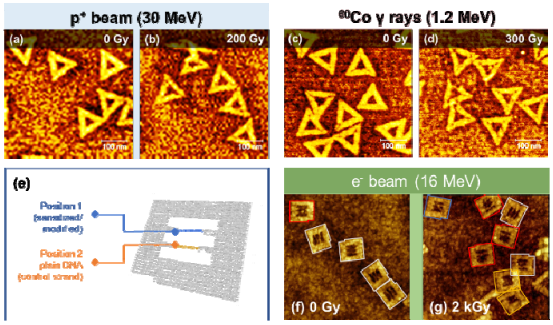

Figure 1: AFM images of control samples (a, c, f); proton irradiated (b) and gamma irradiated DNA origami nanotriangles (d); and electron irradiated DNA origami nanoframes (g). A scheme of the nanoframes is also shown (e).

References

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