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(I) DNA damage as a probe of low-temperature plasma properties and efficacy

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A low-temperature plasma (LTP) is being advanced as an alternative radiation source that offers unique chemical properties owned by a variety of reactive plasma species (RPS), such as radicals, electrons, and excited species, delivered and formed in media upon exposure. Our current research explores the possibility of implementing DNA and its damage as a probe for specific plasma diagnostics such as RPS formation and transient local heating. Both LTP characteristics have been analyzed based upon the detection of plasma-induced strand breaks and DNA denaturation. Our previous studies proved that DNA can be utilized as a probe for RPS, particularly for reactive oxygen and nitrogen species that cause strand breaks in aqueous DNA. Moreover, the yield of strand breaks can be varied by tuning plasma parameters because of DNA's susceptibility to all RPS. Recently we observed previously undetected DNA denaturation in addition to the DNA strand breaks present upon plasma irradiation. Thus, our primary focus has been to determine whether DNA denaturation, known to occur during heating, may be a reliable indicator of the plasma's elevated gas temperature. In parallel, we performed measurements of LTP gas temperature using a conventional temperature sensor. Surprisingly, we observed denaturation at the combination of plasma parameters that form the jet with a temperature much below the thermal decomposition of DNA. To understand this effect, we implemented a physics-guided neural network model to predict the formation of strand breaks and denaturation and their yields for a given combination of LTP parameters. Using predictive modeling, we obtained the evolution of these two types of DNA damage as a function of voltage (and power), frequency, flow rate, and irradiation time. Based on our findings we suggested that denaturation of DNA can be attributed to transient local heating of the aqueous DNA, ("hotspots"), while bulk heating was not observed.

Keyword-1

DNA damage

Keyword-2

plasma

Keyword-3

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