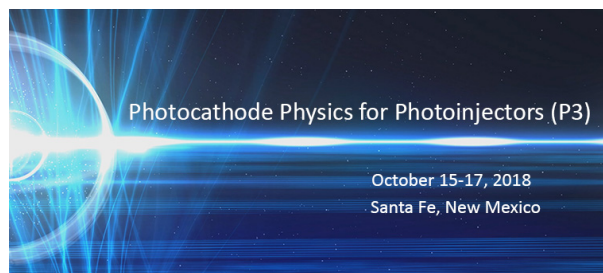


Photocathode Physics for Photoinjectors 2018



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Engineered Nanodiamond Photocathodes

Monday, October 15, 2018 11:00 AM (15 minutes)

n-type ultra-nano-crystalline diamond (n-UNCD, a synthetic polycrystalline, a mix of sp³ and sp² phases, diamond with semimetallic electron conductivity) has emerged as a negative electron affinity (NEA) photocathode platform that can be engineered toward a specific targeted application. This presentation summarizes our experimental results related to (i) quantum efficiency (QE); (ii) ruggedness/lifetime; (iii) emittance/mean transverse energy (MTE); (iv) time response of n-UNCD photocathode structures. NEA can be induced on UNCD via surface treatment in hydrogen. Such NEA is stable against air exposure for extended time. The combination of air resistant NEA and n-doping is the key to engineer low work function. Nitrogen-doped UNCD, (N)UNCD, processed in H₂ plasma demonstrated QE \gg 0.1% at 254 nm and enhanced photoelectric response at wavelengths up to 400 nm. Recently, it was experimentally established that submicron (N)UNCD photocathodes feature optical interference. This effect suggests strong optical density enhancement on the photocathode surface and minimized delay in photoelectron emission (potentially prompt response time) and points out a viable path to engineer optical response window of the photocathode to further enhance QE. Lastly, we measured MTE of a (N)UNCD cathode that was found to be .250 meV with weak dependence on the photon energy. We will outline a concept that link together our experimental results with the graphitic patch model according to which electrons in UNCD are emitted from sp² graphitic grain boundaries, implying that the effective mass of emitted electrons is $\frac{1}{18}$ of the free electron mass and explaining weak MTE dependence on the excess energy of the primary photons. This fact together with nanometer surface roughness could pave a way to a small intrinsic emittance.

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