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2D material integration with cathodes for accelerators

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The studies commissioned by the U.S. Department of Energy have repeatedly identified electron sources as critical risk area for development of future accelerators including LINAC. To address this challenge, we initiated an effort of integrating 2D materials with cathodes in 2013. The aim was to protect environmentally susceptible but high performing alkali antimonide semiconductor photocathodes with atomically thin two-dimensional (2D) materials such as graphene. The concept behind the effort was to decouple the competing mechanisms of high quantum efficiency and long lifetime. Our team succeeded in demonstration of the concept on metal photocathodes in 2017, won R&D 100 Award in 2019 and recently succeeded in demonstrating graphene encapsulated potassium caesium antimonide photocathodes to remain active in 3 orders of magnitude higher pressure compared to non-protected counterpart. The breadth of possibilities of 2D material integration with cathodes for accelerators will also be covered based on our findings during past decade such as graphene as reusable substrates for alkali antimonide photocathodes, prevention of alloying between substrate material and alkali antimonide photocathode by graphene coating, demonstration of no detectable emittance increase on metal single crystal photocathodes by graphene coating, and work function lowering of thermionic- and photo-cathodes by monolayer hexagonal boron nitride coating.

Footnotes

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