AN ULTRACOLD CRYOGENIC PHOTOELECTRON SOURCE FOR THE TSR ELECTRON TARGET

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Abstract

We present a cryogenic GaAs photocathode electron source developed for the target section of the Heidelberg Test Storage Ring (TSR) [*], capable of delivering electron currents of 1 mA in continuous operation. While the initial electron kinetic energy spread is of 10 meV [*], adiabatic expansion (magnetic field ratio: 20. . .40) and acceleration (typically to energies of 0.05. . .5 keV) reduce the energy spreads transverse and longitudinal to the beam direction down to 0.5. . .1 meV and 0.02. . .0.04 meV respectively [**]. Recently, the performance and stability of the photocathode source has been significantly improved. This was achieved by controlling several quantum yield degradation effects, including cryosorbtion at the sample surface, vacuum degrading desorbtion induced by loss electron currents, and backstreaming of ionised restgas particles through the beam optics. Presently, we obtain electron currents of up to 1 mA at photocathode temperatures of about 100 K and sample lifetimes of at least 24 h. Degraded samples can be quickly replaced by freshly activated ones using a magnetic manipulator. The replacement procedure, including cooling of the new sample to cryogenic temperature takes only 30 min, allowing a practically continuous operation of the electron gun. The instrumental setup ensures an in-vacuum closed operation cycle of the photocathode samples. The preparation chamber of the setup can contain up to four cathode samples and provides facilities for heat-cleaning and cesium/oxygen-activation of the latter. After several duty cycles, the photocathodes can additionally undergo atomic hydrogen cleaning, which fully restores their emission properties. Further work in order to improve current intensity, lifetime, and energy spread of electron beams from GaAs photocathode sources is in progress. Additionnally, different types of wider-band semiconductor photocathodes, believed to be less sensitive to degradation effects, are being studied.

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