Effect of atomic hydrogen exposure on electron beam polarization from strained GaAs photocathodes

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Strained-layer GaAs photocathodes are used at Jefferson Lab and other accelerators to obtain high electron beam polarization. Early attempts to use these photocathodes at Jefferson Lab often met with disappointing results. Beam polarization varied from sample to sample and sometimes over small distances on a single sample.

At Jefferson Lab, all photocathodes are cleaned using atomic hydrogen (or deuterium). This method has a number of advantages over wet chemical etching techniques. Hydrogen-cleaned samples consistently yield high quantum efficiency (QE>10% for bulk GaAs at 780 nm; QE>0.2% from strained-layer GaAs at 840 nm). The method is inexpensive; the main components of the cleaning apparatus are glassware, a small turbo pump and a commercial tank of research grade molecular hydrogen. There are no caustic chemicals to handle and dispose of. Photocathode samples can be processed in vacuum and activated in situ without exposure to air. Or, as is the case at Jefferson Lab with photocathodes used in production photoemission guns, samples can be cleaned with atomic hydrogen in a separate vacuum chamber then removed and loaded into the electron guns using a simple nitrogen filled glove bag and transport tube, with minimal air exposure.

Despite these advantages, there is a potential pitfall to using this cleaning technique. Recent tests indicate that too much exposure to atomic hydrogen can reduce the maximum polarization of the electron beam produced from strained-layer GaAs samples. We will present beam polarization measurements from a number of samples as a function of exposure dose to atomic hydrogen. Preliminary results suggest high quantum efficiency and high beam polarization (~75%) can be obtained from SPIRE (now Bandwidth Semiconductor) strained-layer GaAs photocathodes with much greater regularity than initially believed during our initial tests.

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