Characterization of a back thinned scientific CMOS imager with extended ultra violet and soft X-rays

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Introduction

Photon science with extended ultra violet (EUV) to soft X-ray photons generated by state of the art synchrotrons and FEL sources imposes an urgent need for suitable photon imaging detectors. Requirements on such EUV detectors include high quantum efficiency, high frame rates, very large dynamic range, single-photon sensitivity with low probability of false positives, small pixel pitch and (multi-)megapixel ability.

CMOS detector

The detector is a back illuminated sCMOS imager for soft X-rays in the energy range from 35 eV to 2000 eV. It comprises 2048 x 2048 pixels with a pixel size of 6.5 μm x 6.5 μm. The sensor exhibits a full well capacity of 48000 e− and a readout noise of 1.9 e− (rms) with a dynamic range of 88 dB. The integration time can be adjusted between 10 μs – 2 seconds. The maximum frame rate is given by 48 fps for the full frame. Vacuum compatibility has been obtained by sealing the carrier board of the sensor, which constitutes the barrier between vacuum and normal atmosphere, which allows to keep the entire readout and trigger electronics in air. At the moment a KE flange is utilized to attach the camera and subsequently sensor to the experimental vacuum chamber.

Measurements

Spatial resolution achievable in TwinMic STXM mode was measured with slanted edge samples. The detection limits for spatial frequencies up to 0.4 LP/mm were determined by least square fitting results. A charge spread barrier of 0.5 nm fatty acid, a 0.9 nm insensitive Si layer and 9.9 nm SiO₂ passivation, a Si epilayer of 10.3 nm ±0.2 μm was measured.

Radiation

A twin micromachined detector with 16% threshold (743.0 eV), 50% threshold (594.4 eV), 40% threshold (445.8 eV) and 20% threshold (297.2 eV) of Al edge, can be considered for high energy applications.