High-throughput Toroidal Grating Beamline for Photoelectron Spectroscopy at CAMD

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High-throughput Toroidal Grating Beamline for Photoelectron Spectroscopy at CAMD

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Abstract. A 5 meter toroidal grating (5m-TGM) beamline has been commissioned to deliver 28 mrad of bending magnet radiation to an ultrahigh vacuum endstation chamber to facilitate angle resolved photoelectron spectroscopy. The 5m-TGM beamline is equipped with Au-coated gratings with 300, 600 and 1200 lines/mm providing monochromatized synchrotron radiation in the energy ranges 25-70 eV, 50–120 eV and 100–240 eV, respectively. The beamline delivers excellent flux (~10^{14}-10^{17} photons/sec/100mA) and a combined energy resolution of 189 meV for the beamline (at 1.0 mm slit opening) and HA-50 hemispherical analyzer was obtained at the Fermi level of polycrystalline gold crystal. Our preliminary photoelectron spectroscopy results of phenol adsorption on TiO_2 (110) surface reveals the metal ion (Ti) oxidation.

1. Introduction

The 6 meter toroidal-grating monochromator (6m-TGM) beamline at the Center for Advanced Microstructures and Devices (CAMD) at Louisiana State University was decommissioned in 2008. The 5m-TGM beamline, formally operated at the Electron Stretcher Accelerator (ELSA) Synchrotron Facility, Bonn University, Germany, was relocated to CAMD in 2010 to be installed on the 1.5 GeV CAMD electron storage ring and the same bending magnet port used for the 6m-TGM at CAMD. The beamline commissioning was completed in 2011 and an ultrahigh vacuum (UHV) endstation equipped with a HA-50 electron analyzer was commissioned and attached to the 5m-TGM beamline to facilitate vacuum ultraviolet angle-resolved pho

ellipsoid. Reflected synchrotron light from the focusing mirror with an incidence angle of 84.5° is focused on the entrance slit. The synchrotron radiation is monochromatized using the toroidal diffraction gratings. The monochromator chamber is equipped with ion-etched, Au-coated gratings with 300, 600, and 1200 lines/mm providing highly resolved monochromatized synchrotron radiation in the energy ranges of 25-70, 50–120 eV, 100–240 eV, respectively. All three toroidal gratings are placed on a cradle, which can be moved horizontally with an extended arm operated with a motor outside of the grating chamber, allowing easy grating exchange. The 5m-TGM beamline does not have a refocusing mirror after the exit slit, and this contributes to the high-throughput nature of the beamline. The monochromatic light from the grating is parallel to the floor and produces a beam-spot size of 5 mm x 2 mm at the sample position with a 1mm vertical and 10 mm horizontal openings on the entrance and exit slits.

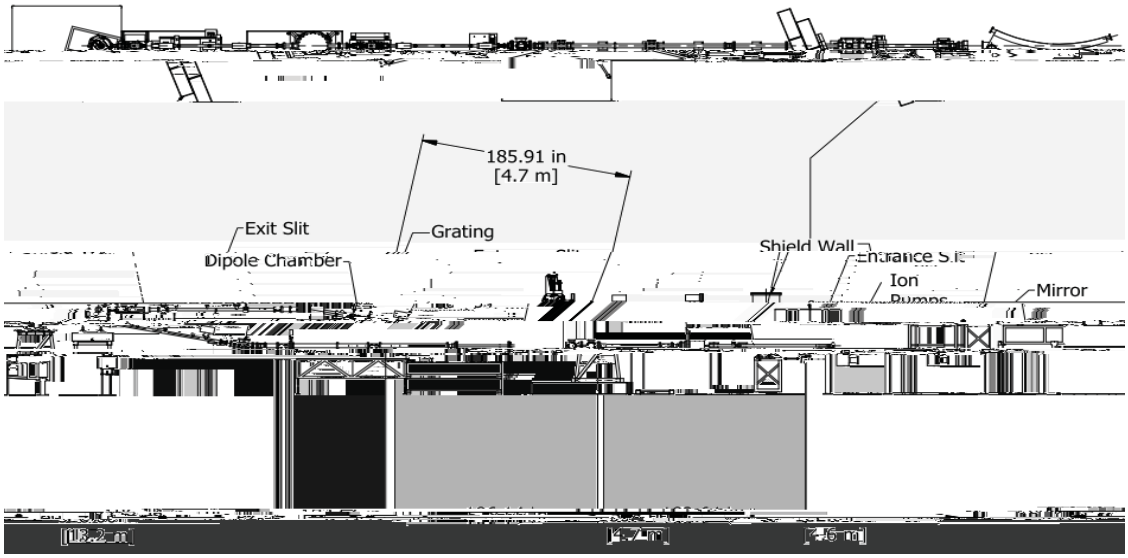

Figure 1. Layout of 5m-TGM beamline at CAMD

The attached ultrahigh vacuum (2×10^{-10} Torr) endstation is primarily used to conduct angle-resolved photoelectron spectroscopy (ARPES) experiments on a variety of materials. The chamber is equipped with a sample load-lock, ion sputtering, and numerous evaporation sources. The sample manipulator allows for full rotation (2-axis) and translation (x-y-z), and facilitates sample temperatures between 90-1600 K. In the case of ARPES data acquisition, photoelectrons emitted from a sample in the endstation are collected with a VSW HA-50 hemispherical electron analyzer, which rotates along 2-axes. This allows for full Brillouin mapping with differing polarizations. The voltages applied to the electrostatic lenses of the analyzer are controlled by a VSW-HAC 300 power supply. The VSW-HAC 300 controller floats over a Valhalla 2701C programmable DC voltage supply controlled by a GPIB interface to set the kinetic energy range of a scan. The charge-signal pulse from a channeltron is capacitively coupled into a voltage signal pulse with an electronic circuit placed outside the vacuum chamber. The pulses are amplified and collected by a timer/counter. A normalization current, proportional to the incoming flux, is also available. A data acquisition program written in LabVIEW program at CAMD records the counts and plots the photoelectron spectrum. The LabVIEW program also controls the grating rotation and its move to an intended photon energy position.

Photon flux delivered by each grating was measured with a GaAsP diode placed at the