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Commissioning of a new beamline and station for ARPES at NSRL

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Abstract

The commissioning of a new beamline and station for angle-resolved photoelectron spectroscopy (ARPES) at the National Synchrotron Radiation Laboratory (NSRL) in Hefei is described. The beamline employs a variable angle spherical grating monochromator (VASGM) covering the photon energy from about 10 to 300 eV. The resolution and the flux of the beamline have been measured using a gas cell and a calibrated photodiode. The whole range resolving power is better than 1000 and the flux is better than 4×10^{10} photons/s/100 mA which have reached the specification of original design. By using the method of second harmonic spectra for high energy and the valence band spectra for low energy, the whole range incident photon energies have been calibrated. Finally, an ARPES experiment from a standard Cu sample is taken to illustrate the performance of the whole system.
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1. Introduction

Angle-resolved photoelectron spectroscopy (ARPES) using low energy synchrotron radiation is one of the key techniques to study valence band structure and occupied electronic states of solids [1]. It has become a powerful method for mapping the band structure of solids especially using the synchrotron radiation as the excitation source. During the phase II project in National Synchrotron Radiation Laboratory (NSRL), a new beamline and experimental station for ARPES has been established [2]. It is a bending magnet-based synchrotron radiation beamline on the NSRL synchrotron radiation source, a 0.8 GeV electron storage ring. This beamline is designed to be

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operated in the 10–300 eV photon energy range with a resolving power ($E/\Delta E$) better than 1000. According to the original design [3], a variable angle spherical grating monochromator (VASGM) [4,5] has been employed. In this paper we briefly describe the primary commissioning results of this new beamline and station.

2. Beamline and end-station

The beamline layout is shown in Fig. 1. The VASGM is designed to cover an energy range from 10 to 300 eV using three interchangeable gratings. These 200, 600 and 1200 lines/mm gratings cover the energy ranges 10–41, 23–123 and 88–300 eV, respectively. A cylindrical–toroidal pre-focusing system [6] collects 15 mrad (H) $\times$ 2 mrad (V) on the entrance slit and the vertical demagnification ratio of the light source is 3. The grazing angle is 3.5° and the mirror's length is less than 200 mm. A postpositive toroidal mirror is used to focus the monochromatized radiation at the sample position with beam size of $3 \times 1\,mm^2$. The details of this VASGM beamline are described in the Ref. [3]. It has two operation modes: the first one is fixed beam spot on sample by means of fixing the slits while rotating the plane mirror and grating at the same time, the other is acting as a standard SGM by means of having the including angle fixed while the exit slit is movable. The latter brings a small shift of beam spot on the sample, which is intolerable in ARPES experiment, so the first working mode is adopted in our beamline.

The end-station consists of three independent ultra-high-vacuum (UHV) chambers, the main chamber is the analysis chamber equipped with a photoelectron spectrometer, ARUPS 10 from V.G. Micro-Science. It has a 75 mm mean-radius hemispherical electron analyzer on a two-axis goniometer, a low-energy electron diffraction (LEED) system and an ion gun for sputtering. The goniometer has two angles: the polar angle θ which moves the whole goniometer table around the vertical axis of the chamber and the azimuthal angle φ which moves the analyzer up and down. There is no restriction for polar angle, while azimuthal angle has a range from $+5^\circ$ to -95°, which means that the analyzer can only go $+5^\circ$ in the up direction. The angle resolution is 0.4° in both directions [7]. The second chamber employs an AES, sputtering gun and e-beam heater for sample pre-treatment. The sample can be introduced into the UHV through a load-lock chamber, treated by repetition of ion sputtering and annealing to obtain a clean surface. The third chamber is

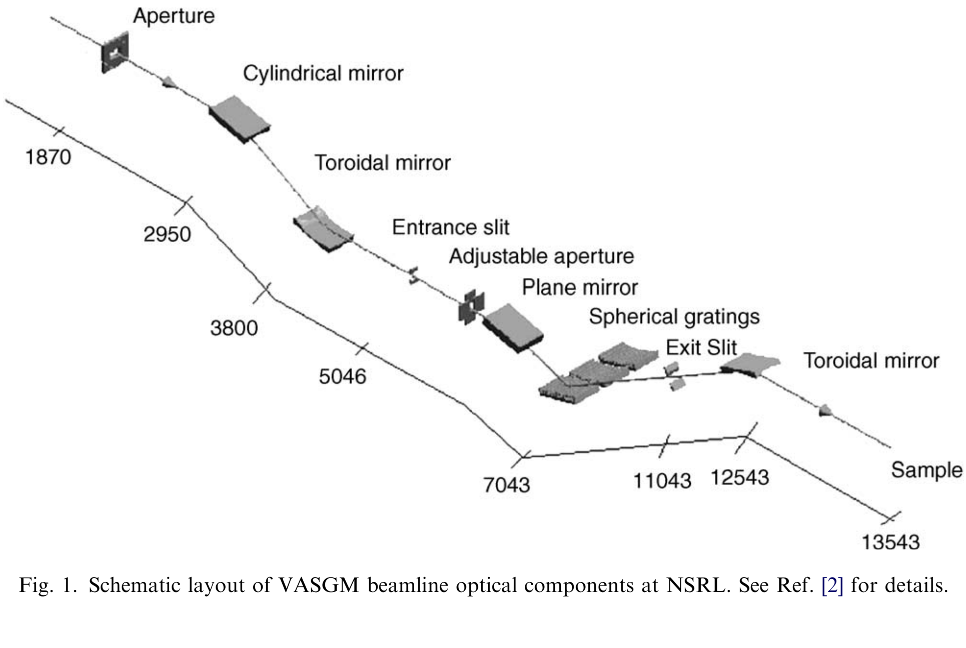

Fig. 1. Schematic layout of VASGM beamline optical components at NSRL. See Ref. [2] for details.

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