

DA20 Development Note

Compact XPS/UPS/ARPES Analyser with Patented Deflection

The DA20 is a compact analyser for high energy resolution measurements required in XPS and ARPES applications. In addition, the analyser is capable of measuring a full cone of ± 10 degrees opening angle without sample movement making it ideally suited for ARPES.

The DA20 analyser shown in Figure 1 builds on the established R3000 analyser and the revolutionary and patented double deflector concept known from the DA30-L analyser*. Here we present measurements verifying the target specifications of the DA20 analyser with redesigned lens.

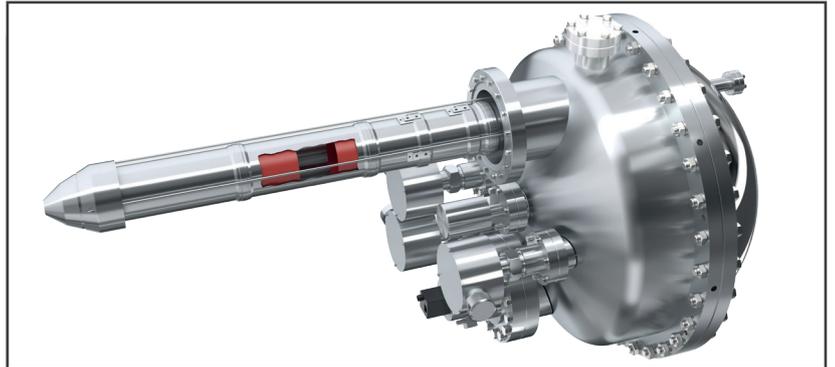


Figure 1: The compact DA20 analyser with redesigned lens system including two deflector elements (red). The deflection capability allows for $\pm 10^\circ$ full cone measurements without changing incident and exit angles.

Deflection Concept

The deflection concept (illustrated in Figure 2) extends the angular range normally limited to the angular dispersive θ_x direction along the θ_y direction. In this way, a full cone of $0^\circ < \theta < 10^\circ$ degrees may be probed without tilting the sample, preserving incident and exit angle. As such, deflection reduces matrix element effects, ensures that the same sample area is probed, and improves the accuracy of measurements perpendicular to the slit.

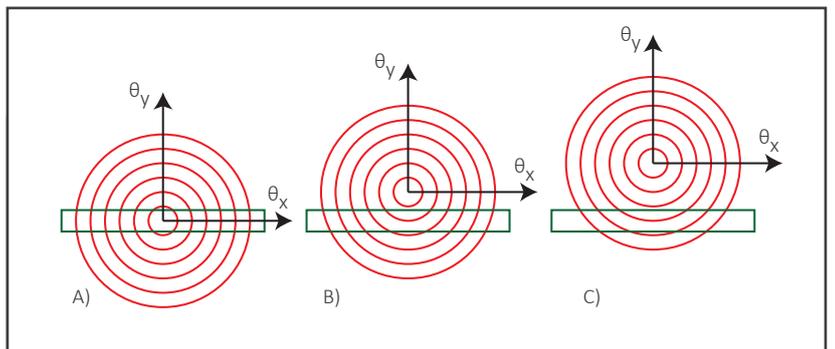


Figure 2: Sequential deflection along θ_y enables measurements of the whole acceptance cone of the analyser without tilting the sample. A: Deflectors off. B and C: Increasing deflection along θ_y .

Verified Performance

The deflection mode of the new lens design is verified with an angular test device (see Figure 3). The test device consists of a fine wire acting as an electron source and a patterned mask. In combination, they generate a well defined angular pattern. Thin slices of θ_x vs E are acquired while θ_y deflection is sequentially increased. Figure 3 shows the accumulated data, clearly showing the angular pattern of the test device in the θ_x and θ_y plane.

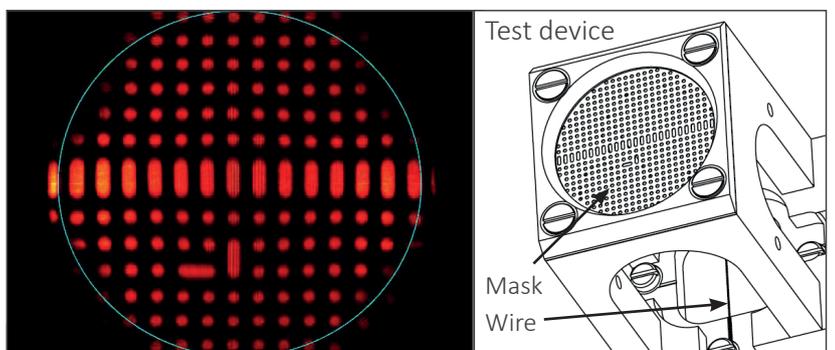


Figure 3: Data acquired with a DA20 analyser during acceptance testing of the deflection mode. The circle marks $\pm 10^\circ$ in the angular pattern. The angular pattern is generated with a test device consisting of an electron source and patterned mask.

The DA20 energy resolution has been measured at a pass energy of $E_p = 2$ eV and with a 0.2 mm slit.

The gas cell uses He I radiation for excitation of Xe $5p_{3/2}$ photoelectrons. The raw measurement data is shown in Figure 4 along with a Gaussian peak fit (blue). The DA20 analyser resolution is better than 3.0 meV.

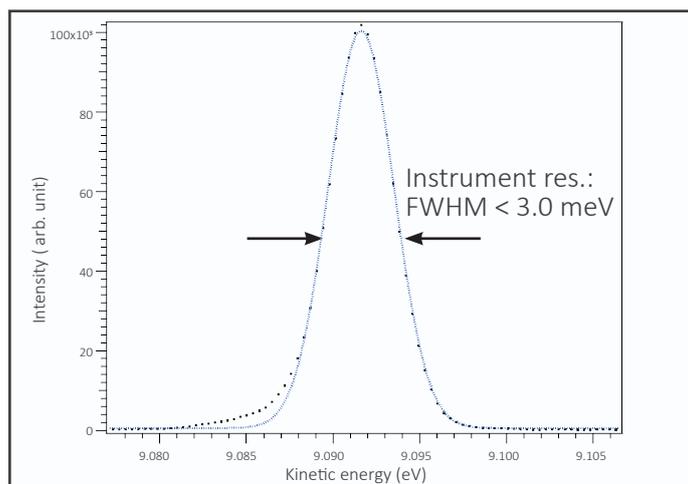


Figure 4: Experimental energy resolution measured on Xe $5p_{3/2}$. After removing Doppler broadening and UV source width, the analyser energy resolution is better than 3.0 meV.

When combining XPS and ARPES experiments, the DA20 upper limit of 1500 eV kinetic energy is crucial. This was verified by measuring the characteristic inelastic background for a Carbon sample excited with 3 keV electrons. Figure 5 shows an XPS spectrum acquired with the DA20 on a Ag sample excited with monochromatic Al-K α radiation.

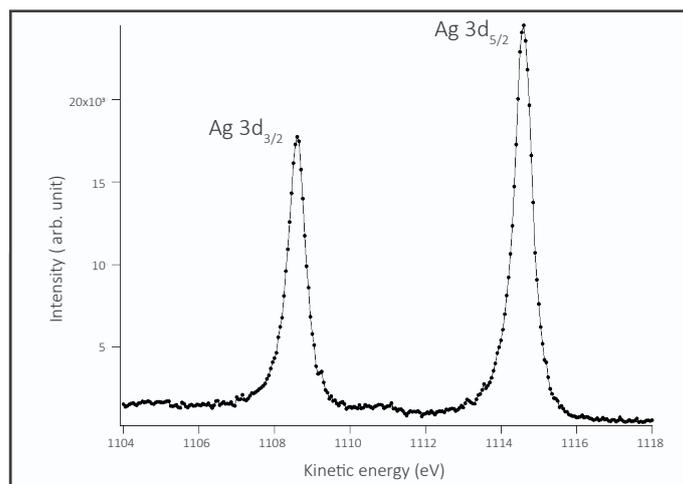


Figure 5: XPS spectrum measured with the DA20 analyser for a Ag sample. The peaks shown here are Ag $3d_{3/2}$ and Ag $3d_{5/2}$ excited by monochromatic Al-K α radiation.

Technical Target Data

Property	Target Specification
Working distance	34 mm
Mounting flange	NW 100 CF, rotatable
Bake-out temperature	< 150 °C
Slits	6
Detector type	MCP/digital camera
Detector interface	Ø 40 mm MCP
Energy channels	> 900 simultaneous
Angular channels	> 700 simultaneous
Detector modes	Pulsed, ADC
Acquisition modes	Swept, Fixed

(*) For 0.1 mm emission spot

Deflection ready models, (R):
All of the DA20 models are available in deflection ready versions. These models are mechanically prepared for deflection, but delivered without deflection electronics. The upgrade to full deflection capability can be done at any time at customer site without breaking vacuum. The performance of these models are identical to the deflection counterparts, except that deflection modes are unavailable.

Model Target Specification	DA20	DA20 TR
Angular/Deflection modes	$\pm 6^\circ, \pm 10^\circ$	$\pm 6^\circ, \pm 10^\circ$
Angular resolution	0.1° (*)	0.1° (*)
Pass energy	2 - 200 eV	2 - 200 eV
Energy resolution	3 meV	3 meV
Kinetic energy range		
Transmission mode	0.5 - 1500 eV	0.5 - 1500 eV
Angular mode	3 - 1500 eV	0.5 - 1500 eV
Deflection mode	3 - 200 eV	1.8 - 200 eV

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