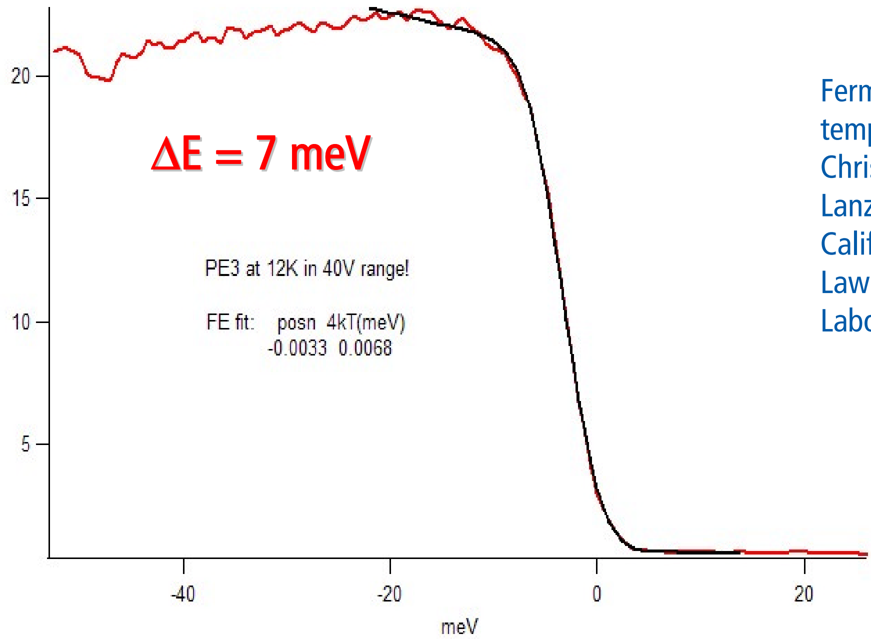
Fermi-edge of a single crystal $TiTe_2$ sample at low temperature (PHOIBOS 150)

Application Notes

The Fermi-edge of a single crystal $TiTe_2$ sample was measured at low temperature. The diode closest to the sample read 12 K. A sample temperature of 17 K was estimated. The data was taken with a PHOIBOS 150 CCD analyzer at 3 eV pass energy and with 0.2 mm slit width.



Fermi-edge of $TiTe_2$ at low temperatures. Data courtesy Chris Jozwiak and Alessandra Lanzara (University of California at Berkeley and Lawrence Berkeley National Laboratory).

The Fermi edge of a cold metallic solid is a good testing ground for the analyzer resolution. The Fermi-Dirac distribution gives the fractional distribution of levels at a finite temperature:

$$F(E) = \frac{1}{e^{\frac{E-E_F}{kT}+1}}$$

where E_F is the Fermi energy, T the temperature, and k is the Boltzmann constant (k=1/11600 eV/K). According to the Fermi-Dirac statistics a width of $\Delta E = 4 \cdot k \cdot T = 6$ meV is expected at T = 17K.

At $E_p = 3$ eV with a 0.2 mm slit the contribution of the PHOIBOS analyzer ΔE_A to the total line width of about 4 meV is calculated from:

$$\begin{aligned}\Delta \boldsymbol{E}_A &= \left(\frac{s_1 + s_2}{4R_0} + \frac{\alpha^2}{4}\right)Ep \\ &= \frac{s_1 + s_2}{2R_0}Ep = \frac{s_1}{R_0}Ep \\ &= \frac{0.2\text{ mm}}{150\text{ mm}} \cdot 3\text{eV} \\ &= \mathbf{4\ meV}\end{aligned}$$

is confirmed by the deconvolution 7^2-$6^2 \approx 4^2$ of the experimental data: 4 meV

Here, S_1, S_2, R_0, α and E_p are the width of the entrance slit, the width of the exit slit, the mean radius of the analyzer, and the pass energy, respectively.

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