Table 2.3.5.2. *β filters for common target elements*

Target element	β filter	$K\beta_1/K\alpha_1 = 1/100$ (mm)	g cm^{-2}	% loss $K\alpha_1$	$K\beta_1/K\alpha_1 = 1/500$ (mm)	g cm^{-2}	% loss $K\alpha_1$
Ag	Pd	0.62	0.074	60	0.092	0.110	74
	Rh	0.062	0.077	59	0.092	0.114	73
Mo	Zr	0.081	0.053	57	0.120	0.078	71
Cu	Ni	0.015	0.013	45	0.023	0.020	60
Ni	Co	0.013	0.011	42	0.020	0.017	57
Co	Fe	0.012	0.009	39	0.019	0.015	54
Fe	Mn	0.011	0.008	38	0.018	0.013	53
	Mn_2O_3	0.027	0.012	43	0.042	0.019	59
	MnO_2	0.026	0.013	45	0.042	0.021	61
Cr	V	0.011	0.007	37	0.017	0.010	51
	V_2O_5	0.036	0.012	48	0.056	0.019	64

The advantage of placing the monochromator in the diffracted beam is that it eliminates specimen fluorescence except for the wavelength to which it is tuned. In conventional focusing geometry, the receiving slit controls the resolution and intensity. The set of parallel slits that limits the axial divergence in the diffracted beam can be eliminated because the crystal has a smaller effective aperture. By eliminating the slits and the $K\beta$ filter, each of which reduces the intensity by about one half, there is about a twofold *gain* of intensity. The results are the same using the parallel or antiparallel position of the graphite with respect to the specimen. The dispersive setting makes it easier to use shielding for radioactive samples.

There is no advantage in using a perfect crystal such as Si after the receiving slit because it does not improve the resolution or profile shape, and the intensity is much lower. However, if the monochromator is to be used in the incident beam, it is advisable to use a high-quality crystal because the incident-beam aperture and profile shape are determined by the focusing properties of the monochromator. A narrow slit would be needed to reduce the reflected width of a graphite monochromator and would cause a large loss of intensity.

The use of a small solid-state detector in place of the monochromator should be considered if the count rates are not too high (see Subsection 7.1.5.1).

2.3.5.4.2. *Single and balanced filters*

Single filters to remove the $K\beta$ lines are also used, but better results are generally obtained with a crystal monochromator. The following description provides the basic information on the use of filters if monochromators are not used. A single thin filter made of, or containing, an element that has an absorption edge of wavelength just less than that of the $K\alpha_1$, $K\alpha_2$ doublet will absorb part of that doublet but much more of the $K\beta$ line and part of the white radiation, as shown in Fig. 2.3.5.3. The relative transmission throughout the spectrum depends on the filter element and its thickness.

A filter may be used to modify the X-ray spectral distribution by suppressing certain radiations for any of several reasons:

(1) *β lines*. β-line intensity need be reduced only enough to avoid overlaps and difficulties in identification in powder work. In single-crystal work, the large peak intensities may require a larger reduction of the β lines, which may be virtually eliminated if so desired. The $K\alpha$ intensity is also reduced by the filter. For example, a 0.015 mm thick Ni filter reduces Cu $K\beta$ by 99% but also reduces Cu $K\alpha_1$ by 60%.

(2) *Continuum*. The continuum is reduced by the filter but by no means eliminated (see Fig. 2.3.5.3). The greatest reduction occurs for those wavelengths just below the *K*-absorption edge of the filter. The reduction of the continuum appears greater for Mo than for Cu and lower atomic number targets because the Mo *K* lines occur near the peak of the continuum. Care must be taken in measuring integrated line intensities when using filters because the *K*-absorption edge of the filter may cause an abrupt change in the background level on the short-wavelength side of the line.

(3) *Contaminant lines*. Lines arising from an element other than the pure target element may be absorbed. For example, an Ni filter is an ideal absorber for the W *L* spectrum.

The filter thickness required to obtain a certain $K\beta_1$: $K\alpha_1$ peak or integrated-intensity ratio at the detector requires the unfiltered peak or integrated-intensity ratio under the same experimental conditions. Then,

$$t = \ln\left\{\left(\frac{K\beta_1}{K\alpha_1}\right)_{\text{unfilt}}\left(\frac{K\alpha_1}{K\beta_1}\right)_{\text{filt}}\right\}\Big/(\mu K\beta_1 - \mu K\alpha_1), \quad (2.3.5.2)$$

where the thickness t is in cm and μ is the linear absorption coefficient of the filter for the given wavelength. Table 2.3.5.2 lists the calculated thicknesses of β filters required to reduce the $K\beta_1$: $K\alpha_1$ integrated-intensity ratio to 1/100 and 1/500 for seven common targets. A brass filter has been used to isolate W $L\alpha$. The *L*-absorption edges of high atomic number elements have been used for filtering purposes, but the high absorption of these filters causes a large reduction of the $K\alpha$ intensity.

The object of filtering is to obtain an optimum effect at the measuring device (photographic film, counter, *etc*.), and the distribution of intensity before and after diffraction by the crystalline specimen has to be taken into account in deciding the best position of the filter. The continuum, line spectrum or both cause all specimens to fluoresce, that is, to produce *K*, *L*, and *M* line spectra characteristic of the elements in the specimen. The longer-wavelength fluorescence spectra ($\lambda > 2.5$ Å) are

references