Range and resolution tuning in diode array spectrometers

Diode array spectrometers can be made with either reflection or transmission diffraction gratings. For any given spectrometer configuration (mirrors/lenses, grating, and detector) it is possible to change the wavelength range and resolution by exchanging the diffraction grating to one with a different groove density. For spectrometers based on reflection gratings it is furthermore possible to tune the wavelength range by rotating the grating. This is however, not possible with spectrometers based on transmission gratings - in this technical note we will explain why.

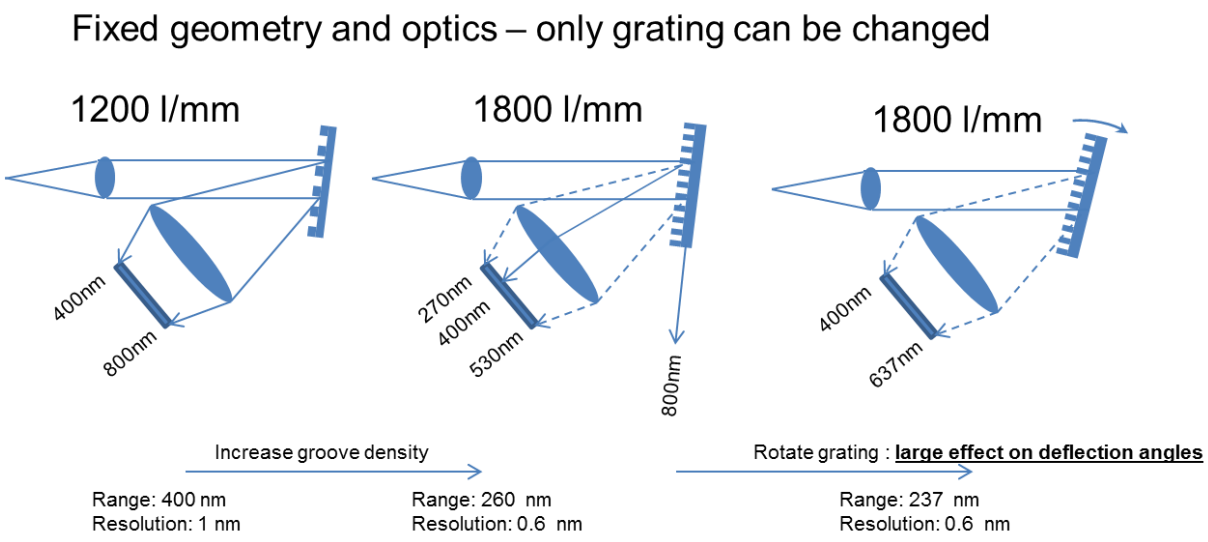

Figure 1: Example of reflection grating based spectrometer and the effect of changing the grating from a 1200 l/mm to an 1800 l/mm grating.

Figure 1 illustrates how the resolution and wavelength range can be changed by changing the grating. To the left we have a spectrometer with a 1200 l/mm grating covering a wavelength range of 400 – 800 nm with a resolution of 1 nm. In the center of Figure 1, the grating is replaced with an 1800 l/mm grating mounted in the exact same position as the previous grating. As can be seen, this changes the wavelength range that hits the detector to 270 – 530 nm and improves the resolution to 0.6 nm. So, basically a large portion of the spectrum has moved to the UV. To the right in Figure 1 it is illustrated that by rotating the grating, we can get the visible spectrum back on the detector (or at least a part of it). This is due to the fact that the diffraction orders from a reflection grating are rotated by roughly 2 times the rotation of the grating itself – just like a mirror.

In figure 2 we show the same grating change and rotation as in Figure 1, but now with a transmission grating in the spectrometer. As can be seen, by changing the grating from the 1200 l/mm grating to the 1800 l/mm grating, we get the same shift in wavelength range and resolution from 400 – 800 nm to 270 – 530 nm and from 1 nm to 0.6 nm, respectively. However, when we try to rotate the transmission grating, nothing happens. This is due to the fact that the orders of a transmission grating do not rotate when the grating is rotated – much like light going through a window.

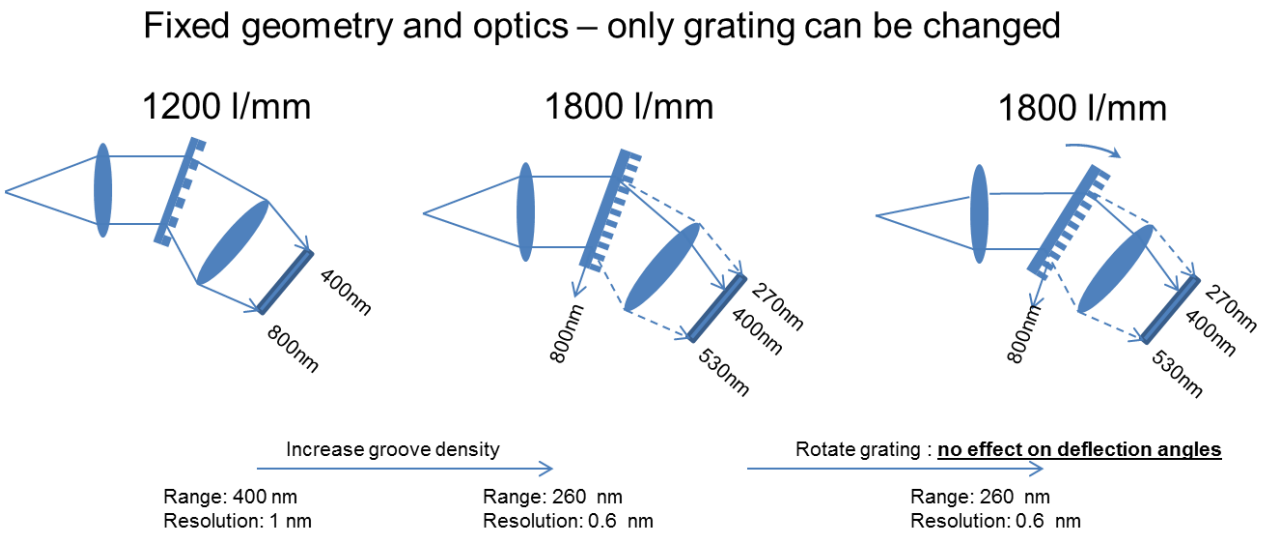

Figure 2: Example of transmission grating based spectrometer and the effect of changing the grating from a 1200 l/mm to an 1800 l/mm grating.

These examples have illustrated that:

- You can change the wavelength range of a spectrometer by changing the grating
- You can tune the wavelength range if the grating is a reflection grating
- You cannot tune the wavelength range if the grating is a transmission grating

What this technical note also illustrates, is that the wavelength accuracy of a reflection grating based spectrometer is extremely sensitive to even small angular rotations of the grating caused by for instance vibrations or temperature fluctuations, whereas a transmission grating based spectrometer is very stable and robust against such angular rotations of the grating.