The main components of a low pressure sodium lamp are as follows.

The *arc tube*; this is made of normal soda lime glass with a coating on the inside of a special sodium resistant aluminoborate glass. Making this 'ply-glass' tube is technically difficult as great care is needed to ensure that there are no thermal stresses in the final tube that might lead to cracking during the life of the lamp. Some lamp types have dimples in the side of them to act as reservoirs of sodium.

The *gas fill* of the tube is neon with about 1% of argon at a pressure of approximately 1000 Pa. This mixture is used as it has a much lower breakdown voltage than neon on its own and thus makes starting the lamp much easier. Sodium metal is also put into the tube. The sodium vapour pressure in the tube when it is at its operating temperature of 260 °C is about 0.7 Pa.

The *outer bulb* is of soda lime glass, the inside is coated with a layer of indium oxide. This layer reflects the bulk of the infrared radiation from the arc tube and thus keeps it warm. Between the outer bulb and the arc tube the gas pressure is very low, below 0.01 Pa. To maintain the vacuum a barium getter is used.

A relatively high voltage is needed to start an arc in the neon fill gas. The arc then slowly warms up the lamp and the discharge tube and the vapour pressure of the sodium starts to rise until the lamp reaches thermal stability after about 15 minutes.

One of the curious properties of the sodium atom is the predominance of the energy transitions associated with the two spectral lines at 589 nm and 589.6 nm. This means that virtually all the visible radiation from the lamp is given off in this very narrow band. However, sodium atoms will also re-absorb and re-emit the radiation very readily; this means that nearly all the light emerging from a low pressure sodium lamp has come from close to the arc tube wall.

The light from a low pressure sodium lamp is a wavelength close to the peak of the photopic sensitivity curve, and as the lamp is relatively efficient at converting electricity into visible radiation, the lamp is one of the most efficient light sources in terms of lumens per watt. The best of the range can achieve in excess of 180 lumens per watt. The problems with the lamp are large size, long run-up time and monochromatic light that does not render colours. The lamp has been mainly used for street lighting but recently the importance of some colour rendering on roads has been recognised and the lamp is rarely used in new installations.

### 3.3.7 High pressure sodium

The high pressure sodium lamp generates light in a discharge through sodium vapour at high pressure. As the vapour pressure of sodium in a lamp rises the spectrum at first broadens and then it splits in two with a gap appearing at about 586 nm. Figure 3.24 shows the spectra from sodium lamps with different vapour pressures.