5. Fluorescence applications

UV lighting is always used in cases where materials require excitation in order to ‘glow’. While the excitation wavelength will depend on the fluorescent medium used, it may be found anywhere within the complete spectrum – from ultraviolet to near infrared. Since industrial processes primarily involve the use of ultraviolet radiation, this part of our Knowledge Base focuses on applications using ultraviolet irradiation.
Fluorescence applications are needed in a wide variety of industries.

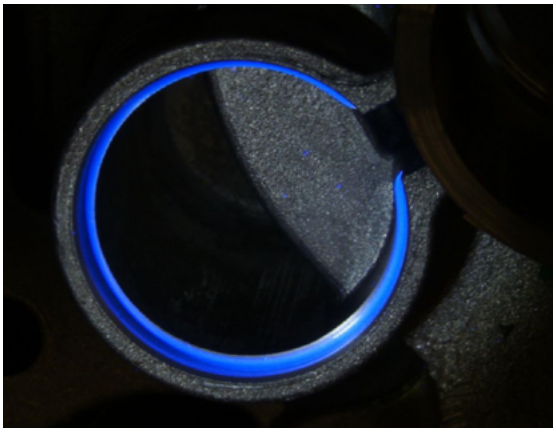
A brief overview of typical applications:

- Inspection of adhesives, paints, sealants and lubricants
- Inspection of safety features and markings as protection against fake and counterfeit goods
- Product labelling
- Track & Trace
- Analysis of residues/residual soiling
- Crack, cavity and defect inspection
- Forensic analyses

Track & Trace in the pharmaceutical industry

The ‘glowing’ described above is luminescence, the generation of light from matter. Luminescence is the optical radiation that occurs during the transition from a stimulated state to the basic state. A key distinction is made between fluorescence and phosphorescence.

- With **fluorescence**, a material emits light while being stimulated, i.e. it starts to glow on exposure to radiation at a certain wavelength. However, this glowing fades as soon as the irradiation ceases.
- **Phosphorescence** describes a similar effect, although the material also continues to glow after irradiation has ended. This ‘afterglow’ can last several hours – or may fade away after a few moments. The duration depends on irradiance and the phosphorescent material itself.



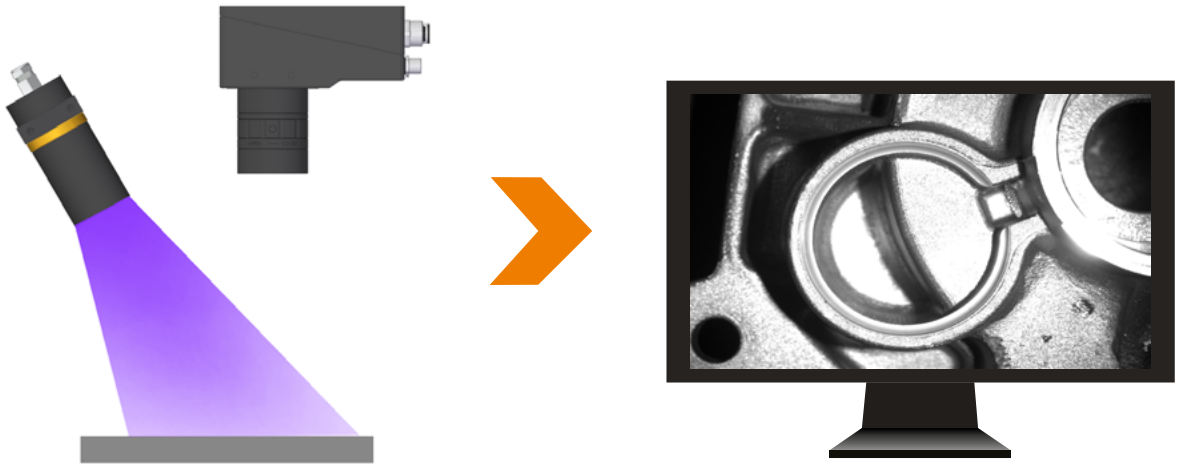
Cast part with fluorescent application under UV irradiation
Left: fluorescence can easily be seen by the human eye

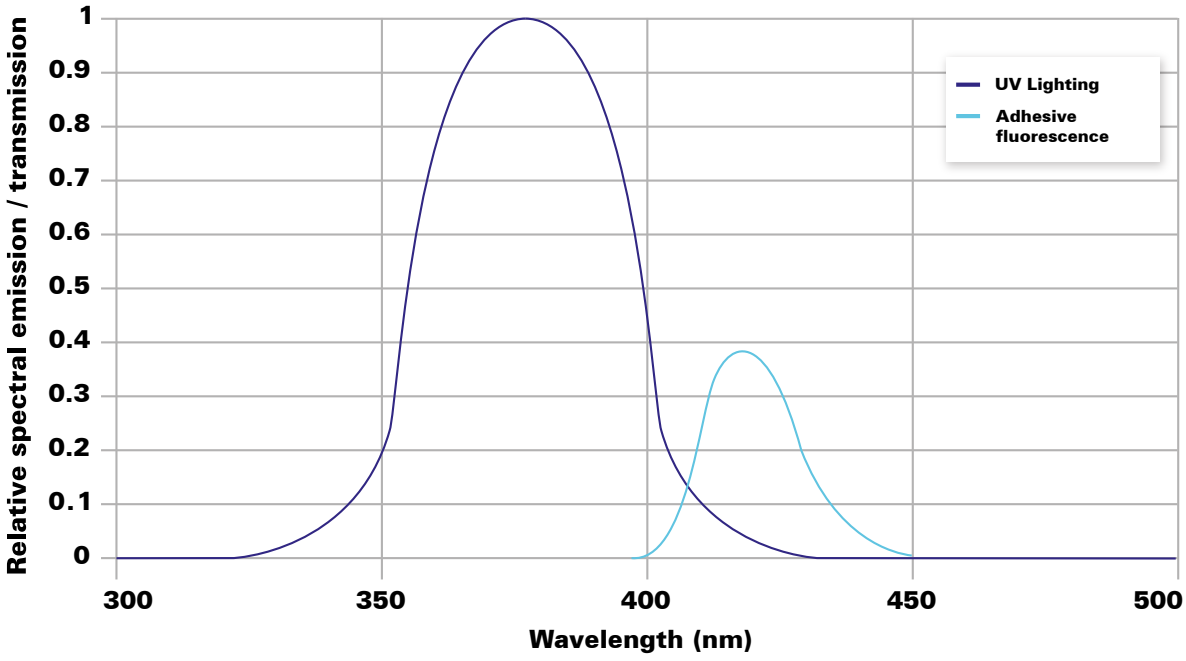
Right: same setting as left but monochrome camera image

5. Fluorescence applications

While the inspection of phosphorescent materials can be performed without using any special filters, one recurring problem with fluorescent materials is that the light emitted has less energy than that the light absorbed. Since fluorescence is easily visible to the human eye, this leads to the miscomprehension that the glow will also be clearly imaged by the camera. The camera is much more sensitive in the ultraviolet spectrum, however, while the human eye barely registers UV radiation at all. In reality, the glow is actually much weaker than the luminous intensity of the UV lighting. In the camera image, the UV light outshines the fluorescence of the stimulated material. Often, the contrast is too weak to ensure a reliable process inspection.

Image acquisition without lens and lighting filter

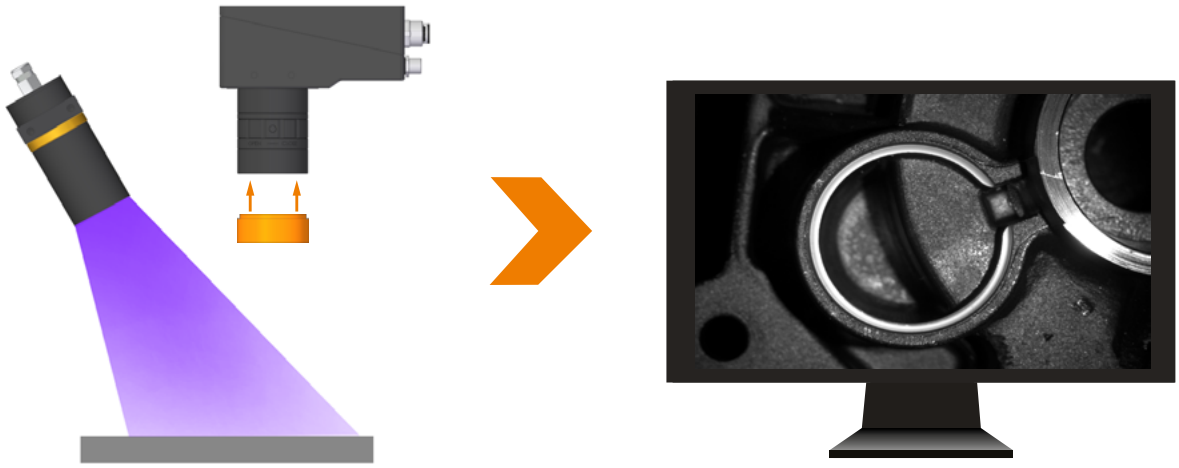


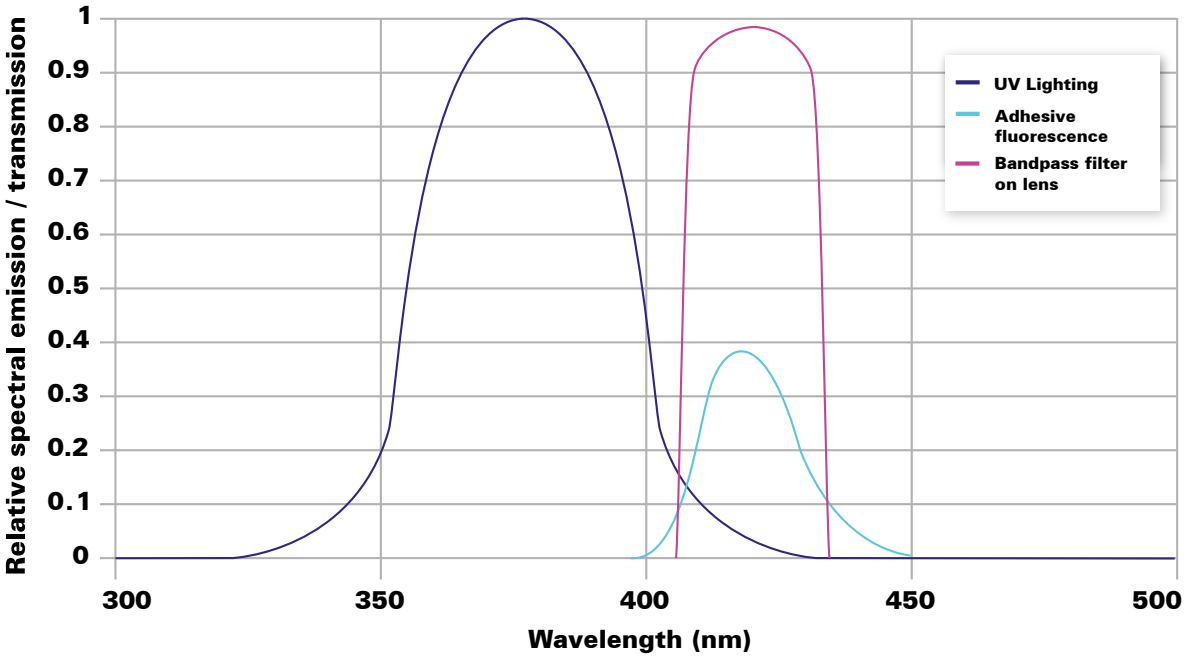


5. Fluorescence applications

To reliably solve these kinds of difficult tasks, the use of a high-performance LED lighting system combined with a specialised filter is recommended.
The most important factor here is the choice of a suitable lens filter. Ideally, a bandpass filter will be used that is precisely matched to the wavelength of the fluorescent material. If the material glows at a wavelength of 430 nm, for example, a filter is selected that lets exactly this wavelength pass, while rejecting all other wavelengths. This not only blocks ambient light but also the vast majority of the required UV radiation. However, since this is not always possible – as in the case of white fluorescence – the use of a longpass filter can also be considered. This is chosen to block all stray light from the UV lighting system.

Image acquisition with lens filter but without lighting filter

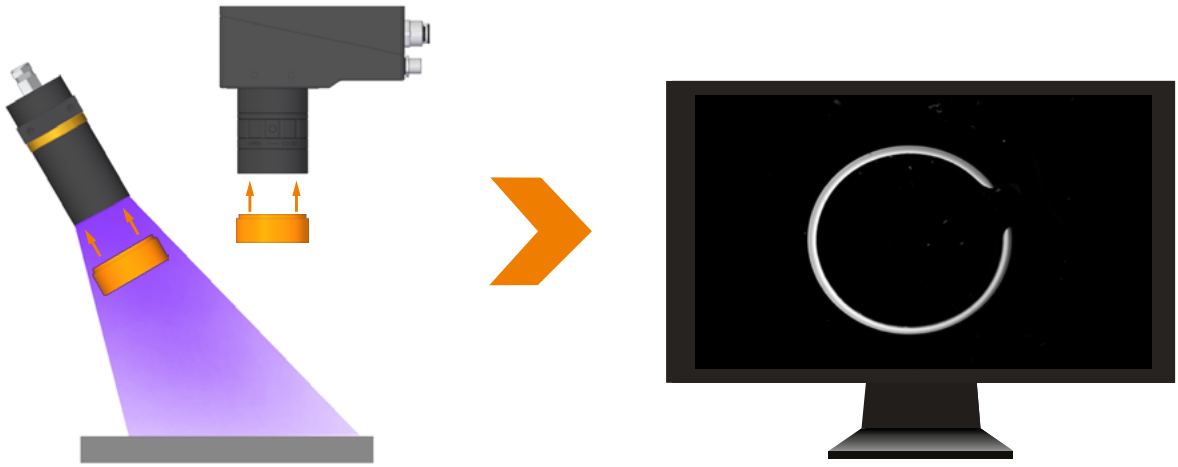


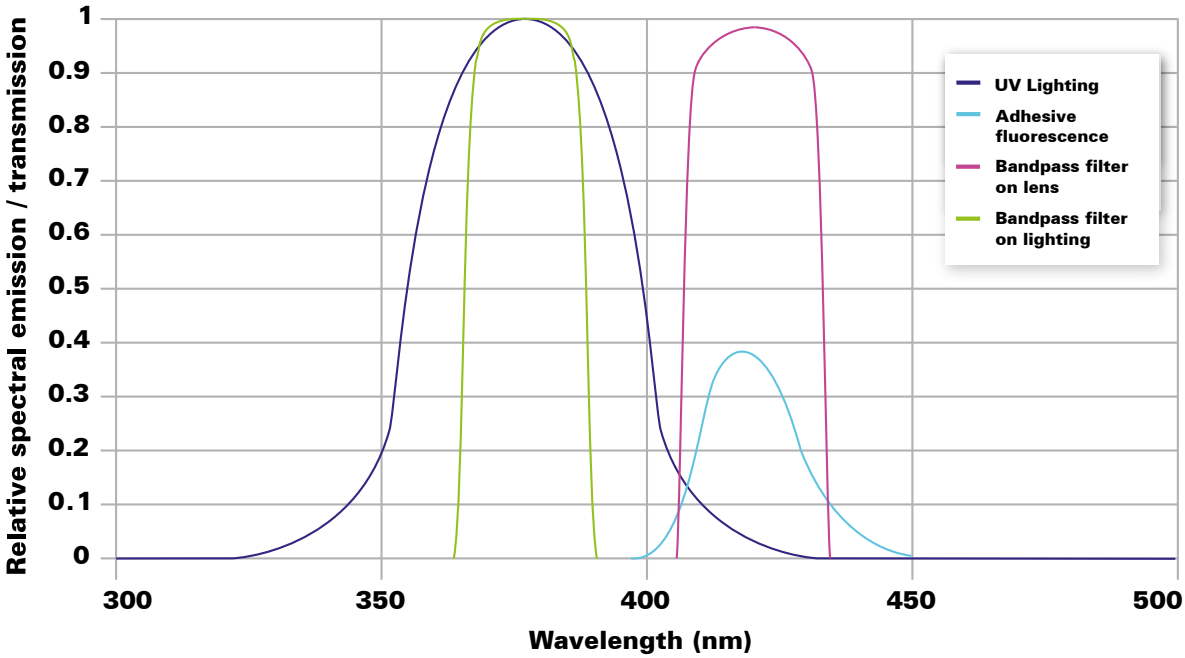


5. Fluorescence applications

UV LEDs emit a very broad spectrum of light, a portion of which contains visible blue light. Blue or white fluorescence in particular makes the choice of a lens filter more difficult, since the spectra of the light source and the fluorescence are very close together. Here, specialised lighting filters are used, which transmit only the UV radiation actually required while attenuating all of the remaining light.

Image acquisition with lens filter and lighting filter





With the use of high-performance LED lighting combined with a perfectly-matched pair of lens and lighting filters, it is possible to entirely eliminate both the light from the lighting system and the distracting light from the environment. As a result, fluorescent features appear as brightly-lit areas in the camera image on a dark background.