

Tunable QCLs for industrial-scale applications

In recent years, Quantum Cascade Lasers (QCLs) have emerged as a **powerful tool in the field of analytical applications**. They have become a popular choice for many industrial applications, with their ability to emit mid-infrared (MIR) radiation, their small size and precise control. However, there are situations where single wavelength characteristics of QCLs can sometimes be limiting. Hamamatsu Photonics has developed a solution to this problem **external cavity tunable QCLs (EC-QCLs)**. These tunable lasers provide an excellent option for applications that require MIR outputs over a range of wavelengths.

Quantum cascade lasers (QCLs) are a special type of semiconductor laser which directly convert electrical energy to MIR radiations spanning a typical wavelength range from 4 µm to 12 µm. QCLs meet all the requirements of an ideal MIR source for analytical applications. They have a small footprint and a collimated output of a few 10s of mW power. QCLs can operate in continuous as well as pulse modes and can be easily controlled with a trigger for synchronized operation. The linewidth of QCLs (typically < 1 MHz) gives them excellent spectral selectivity to quantitatively measure molecular species in complex mixtures. Given the right choice of driver electronics, the output frequency stability of QCLs can be noise-limited in the MIR region, where thermal noise is often an issue^[1]. Therefore, for a given MIR wavelength, the QCL can be a compellingly better choice for industrial applications than solid-state, non-linear lasers which are expensive, large, and difficult to operate.



Hamamatsu Photonics' quantum cascade lasers (QCLs) series.





Figure 1. Before lasing, QCL's gain medium emits broadband light. The grating splits this broadband into individual wave-lengths and reflects only a narrow band back into cavity which sets off QCL lasing.

The single wavelength characteristics of QCLs can sometimes be limiting when a multi-wavelength MIR output is required, for example, to set background for an analytical measurement or to measure multiple molecular species. In such applications, either a combination of QCLs or preferably a tunable QCL is required so that optical integration overheads can be avoided. External cavity tunable QCLs (EC-QCLs) from Hamamatsu are targeted towards applications which require MIR outputs over a range of typically 2 μm (for example 9-11 μm, 8-10 μm or 10-12 μm). The output wavelengths can be selected in any order within the designed 2 µm range or swept across the whole range. The wavelength tuning feature of EC-QCLs is based on reflective grating which is rotated using MEMs technology. As shown in figure 1 and 2, the grating at its rotation axis is aligned with the laser cavity so that for each angle of the grating, only a narrow set of wavelengths couples with the laser cavity and that determines the output wavelengths.

Hamamatsu provides a **convenient plug-and-play EC-QCL**^[2] which is easy to operate by connecting with other accessories^[3]. It is designed mainly for our **academic customers** or for **quick evaluation by development engineers in the industry**.

Hamamatsu also provides **OEM versions** of this product in a butterfly package for **high-volume ap-plications**, which can be customized specifically for industry needs.

Visit <u>www.hamamatsu.com</u> to learn more about QCLs or discuss your analytical and QCL needs with our engineers via <u>info@hamamatsu.eu</u>.



Figure 2. QCL when lasing with one wavelength.

References

^[1] <u>https://www.hamamatsu.com/eu/en/product/lasers/semiconduc-tor-lasers/qcls.html</u>

^[2] https://www.hamamatsu.com/eu/en/product/lasers/semiconductor-lasers/qcls/wavelength-swept-pulsed.html

^[3] https://www.hamamatsu.com/eu/en/product/lasers/semiconductor-lasers/qcls/wavelength-swept-pulsed/connection-examples.html



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