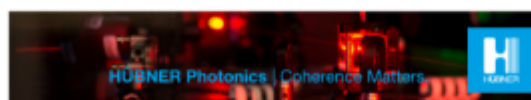




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Tunable Laser Light Sources Advance Quantum Research

Optical parametric oscillators offer a competitive alternative to conventional lasers for quantum nanophotonics.

BY JAROSLAV SPURLING AND
KORBINIAN WENIG, HÜBNER PHOTONICS

A remarkable number of photonic applications call for continuous-wave (cw) laser light that is widely tunable throughout the visible range of the spectrum. However, this spectral region remains difficult to access with conventional tunable laser devices. This is why recently commercialized sources based on cw optical parametric oscillator (OPO) technology have gained market awareness – and become increasingly recognized as cost-effective and user-friendly turn-key solutions. In this white paper, the basic operating principles of such cw OPOs is discussed, followed by an illustrative example of how these OPOs help researchers analyse colour centers in diamond.



OPO technology provides laser light that is widely tunable across the visible spectral range. Figure courtesy of Jens Essling (Physikalisches Institut für Physikalische Messtechnik).

Principles of OPOs

Optical parametric oscillators (OPOs) might be considered as light sources that deliver coherent radiation very similar to lasers – but there are two main differences (1). First, the OPO principle relies on a process referred to as parametric amplification in a so-called nonlinear optical material, rather than on stimulated emission in a laser gain medium. Second, OPOs require a coherent source of radiation as a pump source, unlike lasers, which might be pumped with either incoherent light sources or sources other than light.

In the basic scheme common to OPOs and other optical parametric devices, the process can be perceived as splitting of an incoming pump photon of high energy into two photons of lower energy, the latter usually referred to as signal and idler photons, respectively. It is essential

to note that the overall process is subject to the conservation principles of photon energy and photon momentum (phase matching conditions), but otherwise does not involve further fundamental restrictions, at least in theory. The huge potential of OPOs thus derives from their exceptional wavelength versatility, as they are in principle not limited by the wavelength coverage dictated by the energy levels and suitable transitions in a laser gain medium.

In practice, the OPO concept has been experimentally demonstrated already more than half a century ago (2), but the progress in development and commercialization of turn-key devices has been stalled substantially by several technical obstacles (3). Simply speaking, these obstacles have been easier to overcome at the high peak powers of pulsed devices,

so that tunable OPOs operating in pulsed mode have become readily available from a variety of suppliers. Only relatively recently, there have been comparable advances in continuous-wave (cw) OPO technology (4), which have spurred the development of commercial systems.



Fig. 1 Commercialized cw OPO turn-key system designed to cover the visible spectral range, as available from Hübner Photonics. The platform provides extended wavelength versatility in the range 400–800 nm.

www.huebner-photonics.com
Heinrich-Hertz-Strasse 2
34229 Kassel, Germany

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