Highlights

Activity E - Advanced materials and techniques for organic electronics, biomedical and sensing applications - 2021

Optical parametric amplification by monolayer transition metal dichalcogenides

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Optical parametric amplification is a second-order nonlinear process whereby an optical signal is amplified by a pump via the generation of an idler field. This mechanism is inherently related to spontaneous parametric down-conversion, which currently constitutes the building block for entangled photon pair generation, a process that is exploited in modern quantum technologies. In this paper experimental demonstration is provided of a single-pass optical parametric amplification at the ultimate atomic thickness limits. Using semiconducting transition metal dichalcogenides, amplification over propagation through a single atomic layer has be attained. Such a second-order nonlinear interaction at the two-dimensional limit bypasses phase-matching requirements and achieves ultrabroad amplification bandwidths. In agreement with first-principle calculations, the amplification process has been shown to be independent of the in-plane polarization of signal and pump fields. By the use of AA-stacked multilayers, a clear pathway towards the scaling of conversion efficiency has been proven. The results pave the way for the development of atom-sized tunable sources of radiation with potential applications in nanophotonics and quantum information technology.

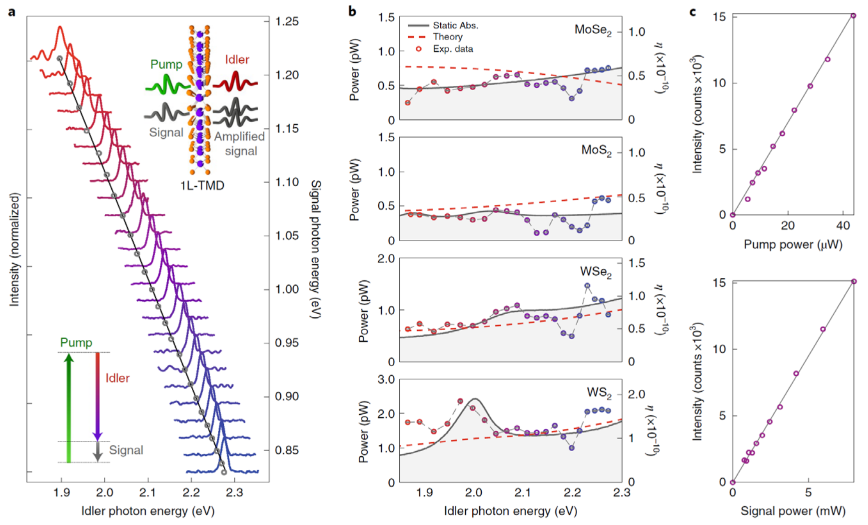

Figure: Broadband OPA in 1L-TMDs.
a Normalized tunable idler spectra measured on 1L-$MoSe_2$; the spectra are vertically offset. The nominal idler photon energy (black solid line) and measured peak values (grey dots) are shown.
b. Absolute idler power and efficiency (η) as a function of the idler photon energy measured on the four semiconducting 1L-TMDs (coloured dots), as well as the corresponding calculated theoretical efficiencies divided by a factor of 2.5 (dashed lines).
c. The idler linear intensity dependence on pump and signal powers measured on 1L-$MoSe_2$.