

Optical Gain in Lasers Based on Two-Dimensional TMDC Semiconductors

Tommy Schulz¹, Daniel Erben¹, Alexander Steinhoff^{1,2}, [Frank Jahnke](#)¹

¹University of Bremen, Bremen, Germany. ²University of Oldenburg, Oldenburg, Germany

Abstract

Despite growing interest, lasers incorporating TMD monolayers as the gain medium are still scarce. We compare the material gain of typical TMD semiconductors to that of standard quantum well laser structures, considering a range of excited carrier densities. The central result of our study is that the material gain in TMDs can be two orders of magnitude higher than in the quantum-well system. This enhancement, however, is accompanied by the need for higher excitation densities and a significant gain rollover for elevated excitation densities due to many-body effects. We also examine how the high material gain manifests as modal gain in typical nanolaser structures, thereby exploring the suitability of monolayer TMDs as active media for semiconductor lasers.