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Optical nonlinearity and ultrafast laser applications of layered materials beyond graphene

E. J. R. Kelleher
Photon Science Section, Department of Physics, Imperial College London, London, UK

1 Extended Abstract

Low dimensional carbon-based materials are now a mature platform for the development of photonic and optoelectronic devices and systems [1], yet researchers continue to shed new light on their physical properties, gain a deeper understanding of their fundamental physics, and exploit their unique characteristics in novel configurations. Perhaps the most prominent of the carbon-based nanomaterials—graphene, a two-dimensional (2d) gapless semiconductor, offers a number of favorable electrical and optical properties that are defined by its unique linear dispersion relation of charge carriers. In particular, graphene exhibits ultrafast carrier dynamics, an ultra-high optical nonlinearity, and a strong saturable absorption, making it a highly desirable platform for the development of next-generation photonic technologies.

While graphene remains the most widely studied layered material, many other mono-layer and few-layer atomic crystals have emerged, becoming the focus of an intensive research effort [2]. Of these, the family of transition metal dichalcogenides (TMDs) is receiving renewed attention because of recent advances in fabrication and preparation techniques, allowing the exfoliation, transfer and manipulation of single atom thick layers, enabling the engineering of 2d crystals. In their atomically thin form, certain TMDs can be direct-gap semiconductors, with bandgaps in the 1-2 eV range, making them an attractive alternative to graphene, where bandgap engineering depends on nanostructuring, chemical doping, or the application of a high electric field to its bilayer form, all of which add complexity [3].

In this talk, I will discuss measurements of the optical nonlinearity of MoS_2 [4], one of the most promising TMDs for photonic applications, and demonstrate how this material is being used as an effective saturable absorber, enabling a range of ultrashort pulse behavior across the near-infrared [5].

References

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