

# Towards Patterned Functionalization of Graphene and Black Phosphorus Heterostructures

**Jasmin Eisenkolb**

Mhamed Assebban, Andreas Hirsch, Frank Hauke

Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Center of Advanced Materials and Processes (ZMP), Dr. Mack-Str. 81, 90762 Fürth, Germany

[Jasmin.eisenkolb@fau.de](mailto:Jasmin.eisenkolb@fau.de)

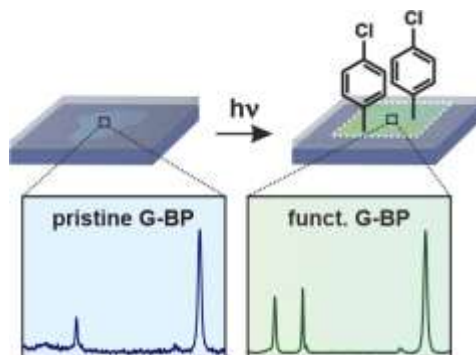
## Abstract

Since the first isolation of graphene, the field of 2D materials has readily evolved. Graphene is a promising candidate for electronic applications, however, its lack of an intrinsic bandgap severely limits its potential.<sup>[1]</sup> Other 2D materials like black phosphorus (BP), an allotrope of the element phosphorus, present unique properties as in case of BP due to its thickness-dependent bandgap and extraordinary electronic characteristics suited for applications.<sup>[2]</sup> Combining specific characteristics of selected materials in an adaptable way represents the ultimate goal, as it allows for the fabrication of specialized material platforms. Hybrid materials are a promising approach towards this goal as they have the potential to combine desired properties of several 2D materials into one. Hence, we investigated the formation of graphene and BP heterostructures and subsequently explored their covalent, laser-induced functionalization. Direct laser writing has emerged as an excellent tool to alter the surface properties of graphene in a straightforward and facile manner and this rationale was adapted to the heterostructure assemblies based on graphene and BP, paving the way for the fabrication of sophisticated 2D material systems and enabling the chemical surface modification of such assemblies in a tailored fashion.

## References

- [1] D. Jariwala, A. Srivastava, P. M. Ajayan, *J. Nanosci. Nanotechnol.*, 11 (2011) 6621–6641.
- [2] X. Ling, H. Wang, S. Huang, F. Xia, M. S. Dresselhaus, *Proc. Natl. Acad. Sci.*, 112 (2015) 4523–4530.

## Figures



**Figure 1:** Schematic representation of the laser-induced, covalent functionalization of a graphene- and BP-based heterostructure assembly with corresponding mean Raman spectra below.