Different PL relaxation mechanism for CVD grown and transferred CVD grown MoS_2

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Two-dimensional (2D) transition metal dichalcogenides (TMDs) possesses extraordinary optical and electronic properties. The most appealing property is the opening of a direct bandgap for monolayer thickness. Extensive experimental and theoretical research explores this direct bandgap and the strong light-matter interaction of the single-layer TMDs and the van der Waals heterostructures, consisting of stacks of single layer TMDS and/or other 2D materials.
In this class of materials, the characterization of the amount and the type of defects is from uttermost importance as the nature of the defects strongly influence the optical and electronic processes, especially the photoluminescence (PL). However, the characterization of the defects is not as straightforward as for graphene films, where graphene's D and D' modes easily indicate the amount and type of defects in the graphene layer at ambient conditions. In contrary, PL recorded down to helium temperatures is the key fingerprint of the defects hence the quality of the TMDs.
In our study, we addressed the defects in chemical vapour deposition (CVD) grown MoS2 monolayers. We observed significant difference between the as-grown monolayers in comparison to the CVD-grown monolayers transferred onto the Si/SiO2 substrate, which contain extra defects due to the transfer process.
We demonstrate that the temperature-dependent Raman and PL micro-spectroscopies enabled us to disentangle the contribution and location of various types of defects in TMD systems.

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