Support information

Ultraviolet Saturable Absorption and Ultrafast CarrierDynamics in Ultrasmall Black Phosphorus Quantum Dots

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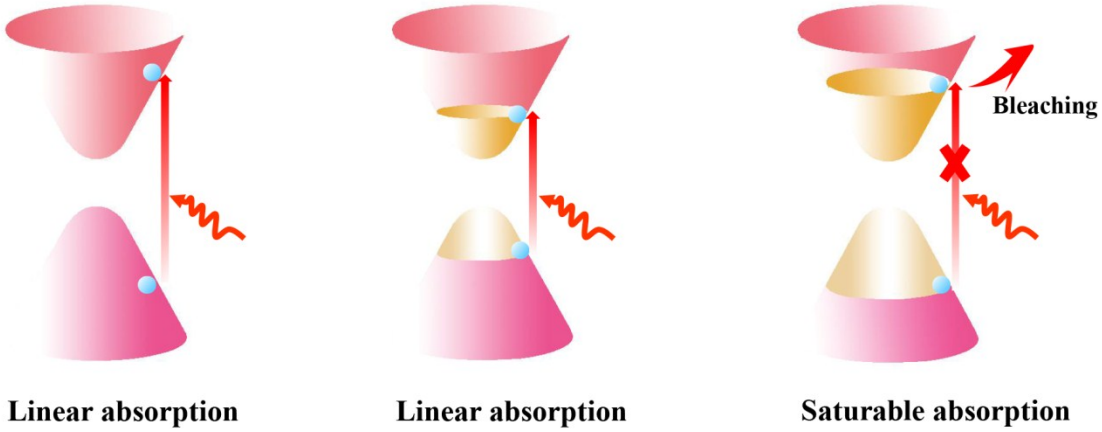

Figure S1. Schematic diagram of optical saturable absorption

We believe that the bleaching of excition absorption dominate the saturable absorption of BPQDs. The saturable absorption mechanism can be explained as follows: under weak excited light with photon energy larger than bulk state bandgap, the electrons in the valance band can be excited to the conduction band, then occupy the state in conduction state; while under the high enough intensity excited light, all the available states in conduction band are occupied by photo-generated carriers; due to the pauli blocking principle, optical bleaching effect is occurrence (i.e., saturable absorption). It is similar to the bleaching of excition absorption in conventional semiconductor and the other 2D materials [1]. Schematic diagram is shown in Figure S1.

Table S1. Comparison of the dynamic relaxation times in different materials.

Wavelength (nm)	Sample	$\tau_{intraband}$	$\tau_{interband}$	References

Pump	Probe				
370	370	BPQDs(3 layers)	--	0.25 ps	Present work
780	1560	BP flakes (80 layers)	180 ps	1.3 ns	Suess *et al*[2]
800	1940	BP flakes (47 layers)	5.96 ps	87.6 ps	Ge *et al*[3]
730	810	BP flakes (30 layers)	20 ps	100 ps	He *et al*[4]
1550	1550	BP nanosheets (3 layers)	24 fs	1.9 ps	Y. Wang *et al*[5]
800	800	BP nanosheets (7 layers)	16 fs	0.36 ps	K.Wang *et al*[6]
1600	1600	BP nanosheets (7 layers)	--	0.92 ps	K.Wang *et al*[6]
790	790	Graphene	130-330 fs	3.5-4.9 ps	Kumar *et al*[7]
633	650	MoS_2 nanosheets	7.1 ps	61.3 ps	Q. Wang *et al*[8]

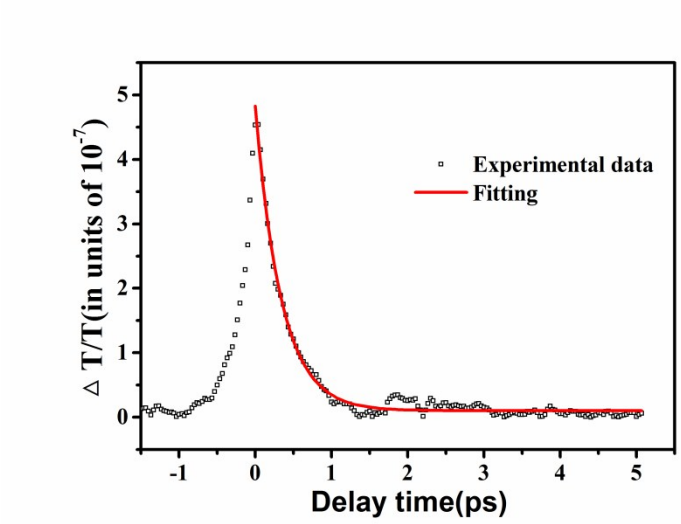

Figure S2. (a) Experimental setup for pump-probe measurement; (b) Pump-probe trace for reference sample 0.3mm ZnS single crystal

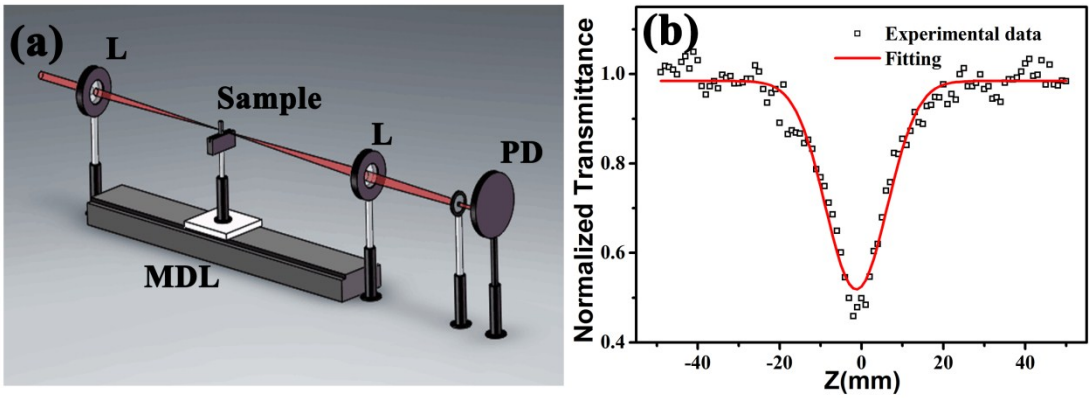

Figure S3. (a) Schematic of the conventional Z-scan measurement: L, lens; PD, photodiode; MDL, mechanical delay line; (b) Z-scan traces for reference sample 0.3mm ZnS single crystal.

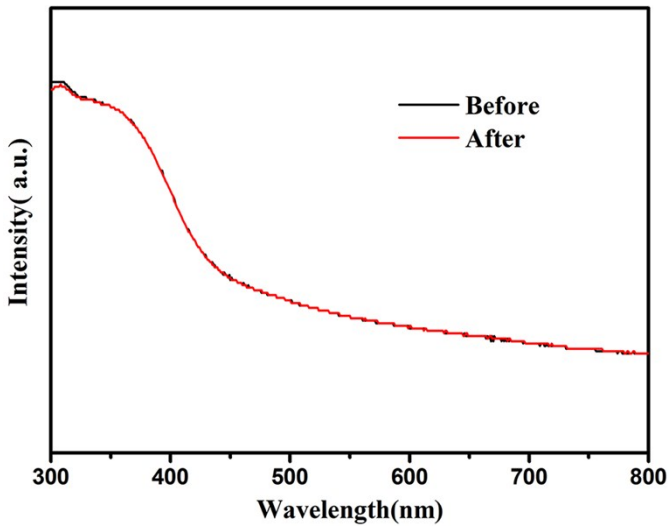

Figure S4. The absorption spectrum of BPQDs before (black line) and after (red line) the experiments

References

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