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Optically Induced Transparency and Extinction in Dispersed MoS_2, $MoSe_2$ and Graphene Nanosheets

Two-dimensional (2D) layered nanomaterials, e.g. graphene and transition metal dichalcogenides (TMDCs), have been demonstrated to be potential candidates for photonic applications benefiting from their multifarious nonlinear optical (NLO) properties. [1-3] All-optical modulation in graphene integrated devices has been demonstrated based on the saturable absorption (SA) effect, which shows ultrashort response time and high modulation rate. [4, 5] Nanosheets dispersion is an interesting system as it has multifarious NLO responses compare with films, for example, nonlinear scattering (NLS) also exists besides SA in various TMDCs dispersions. [6, 7] As a consequence, the optical modulation effects will be more abundant in dispersions. Therefore, it is quite significant to fully understand the NLO mechanism and investigate the optical modulation properties in these dispersions, which is the foundation to exploit optical modulators based on this kind materials. However, few research has been reported on this aspect. In this work, we report the optically induced transparency and extinction in MoS2, MoSe2 and graphene nanosheets in N-methyl-2-pyrrolidone (NMP). The 632.8 nm continuous-wave (cw) can be effectively modulated by 532 nm pulsed laser into signal light with peaks or valleys by tuning the excitation intensity using the pump-probe system. The Z-scan results reveal the coexisting and competition between SA and NLS effects in MoS2 and MoSe2 nanosheets dispersions, which are the main reasons for the optically induced transparency and extinction.

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Figures

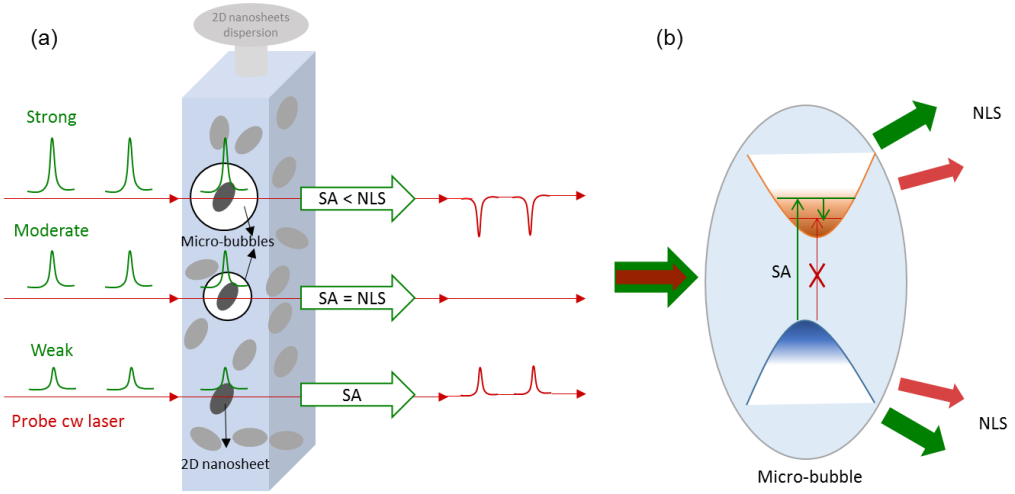

Figure 1: (a) Schematic representation of the all-optical modulation process. (b) Illustration of the SA and NLS mechanism in the nanosheet dispersion.