Measurement of the infrared absorption of a $MoTe_2$ monolayer

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Application Note

Introduction

Monolayers of transition metal dichalcogenides, such as MoS_2, $MoSe_2$, WS_2, and WSe_2, possess optical band gaps in the visible regime. In contrast, the band gap of monolayer $MoTe_2$ is located in the infrared region. One of the most striking features of these atomically thin materials is the presence of excitonic resonances with exceptional high binding energies on the order of hundreds of meV. Here, we measure the absorption of $MoTe_2$ in the infrared regime.

Sample preparation and Measurement

The $MoTe_2$ monolayer is micromechanically exfoliated from a synthetically grown bulk crystal and placed between a 500 µm thick polycarbonate substrate and a polydimethylsiloxane (PDMS) capping layer of 160 µm thickness. For the absorption experiment, white light from a tungsten halogen lamp is focused on the sample with an objective lens (50x/numerical aperture NA = 0.6). The transmitted light is collected behind a second objective lens (50x/NA = 0.6) and imaged on the entrance slit of a spectrograph (Andor Shamrock SR-303i-B) with an attached InGaAs photo diode array (Andor iDus InGaAs DU491A-1.7). By closing the entrance slit to 100 µm and using the 150 lines/mm grating in first order, a transmission spectrum of the sample is recorded.

The optical absorption is derived from light transmitted through the $MoTe_2$ monolayer T_{ml} normalized by the transmitted light through the substrate without monolayer T_{sub}. The absorption is calculated with

$$A_{ml} = 1 - \frac{T_{ml}}{T_{sub}},$$

considering that the reflectivity of the monolayer is negligible compared to the absorption at the excitonic resonances. Figure 1 shows the absorption spectrum of a $MoTe_2$ monolayer with the strong A exciton resonance at 1115 nm.

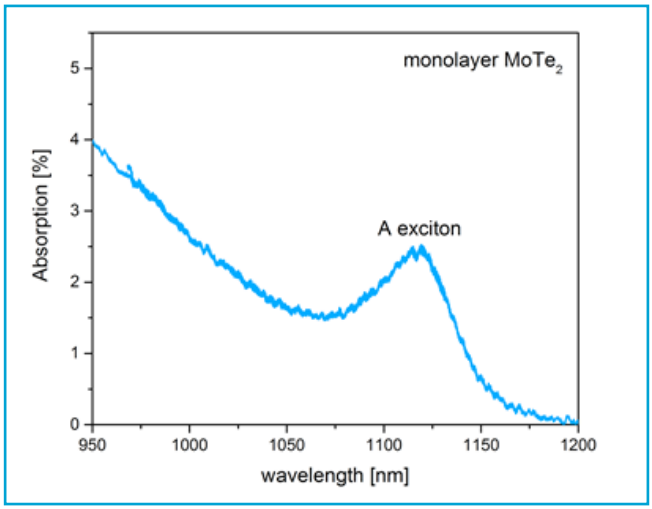

Figure 1: Absorption spectrum of monolayer $MoTe_2$. The A exciton resonance is clearly visible at 1115 nm.

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