Magneto-phonon interaction in layered $Cr_2Ge_2Te_6$ ferromagnet

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Two-dimensional magnets with van der Waals (vdW) structures have recently been revisited due to their potential uses. This fascinating group of materials gives high hopes to improve our spintronics nanotechnology and understanding of magnetic effects in two dimensional structures. Among magnetic vdW materials, $Cr_2Ge_2Te_6$ is a particularly interesting material, as it is in the very rare class of ferromagnetic semiconductors with a Curie temperature (T_c) of about 61 K and exhibits thickness-dependent ferromagnetic transition [1].

In this work, we examine Raman scattering (RS) measured on 10-nm-thick $Cr_2Ge_2Te_6$ flake using an excitation energy of 1.96~eV in a wide temperature range (5-300 K) and with polarization resolution.

The low-temperature (T=5 K) Raman spectrum of the studied $Cr_2Ge_2Te_6$ flake is composed of 7 Raman peaks, see the Figure. Their assignment to two groups of symmetries (E_g and A_g) was confirmed using polarization-resolved Raman experiments. Although most of the Raman peaks experience redshifts with increasing temperature, there are two Raman modes, E_g^2 and E_g^4, marked by red arrows in the Figure, which are sensitive to the transition through the T_c temperature. The E_g^2 peak disappears from the spectra above the T_c temperature, while E_g^2 one experiences nontrivial temperature evolution. Interestingly, the temperature dependence of the E_g^4 mode was already reported in Ref. [2]. In our case, the E_g^4 peak disappears from the Raman spectra above the T_c temperature, while its opposite behavior is observed under excitation energy of 2.41 eV.

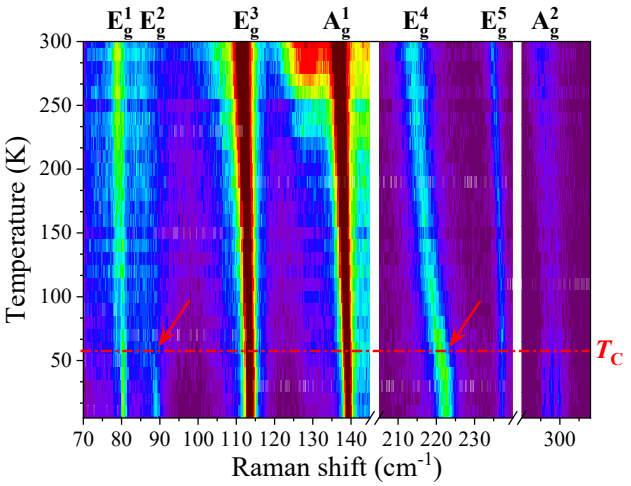

Figure False-colour map of temperature evolution of the RS spectra measured on $Cr_2Ge_2Te_6$ flake. The T_c value is indicated by horizontal red line, while the red arrows point abrupt transition for two peaks around T_c.

Our results demonstrate that the electron-phonon interaction, i.e. interplay between resonant and non-resonant conditions of Raman scattering, may be also important for the magneto-elastic coupling in the magnetic layered materials.

[1] C. Gong, *et al.*, *Nature* **546,** 265 (2017)
[2] Y. Tian, *et al.*, *2D Materials* **3,** 025035 (2016)