Exploring thickness-dependent phonon structure in layered $Cr_2Ge_2Te_6$ ferromagnet

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Vast interest in layered materials with van der Waals (vdW) structures in the last decade resulted in renewed interest in two-dimensional magnets as well, which attributed to their promising applications. This intriguing category of materials holds great promise for advancements in spintronics nanotechnology and enhancing our understanding of magnetic phenomena within two-dimensional structures. Within the realm of magnetic vdW materials, $Cr_2Ge_2Te_6$ (CGT) stands out as a particularly captivating product. It falls into the uncommon category of ferromagnetic semiconductors, boasting a noteworthy Curie temperature (T_c) of approximately 61 K. Moreover, this material displays a ferromagnetic transition that depends on its thickness [1].

In this work, we examine Raman scattering (RS) measured in thin CGT flakes with different thicknesses, using a low excitation energy of 1.6~eV in a wide temperature range (T=5 – 300 K). We also performed measurements on thin flakes subjected to the degradation process in ambient conditions.

The low-temperature (T=5 K) RS spectrum of the studied CGT flakes generally consists of 9 Raman peaks, as depicted in the Figure. These peaks can be categorized into two symmetry groups, E_g and A_g, a classification confirmed by polarization-resolved Raman experiments. Despite the typical redshifting behavior of Raman peaks with temperature, some exhibit high sensitivity to the transition through T_c. Specifically, the E_g^2, E_g^3, and E_g^4 peaks significantly depend on the transition from the ferro- to paramagnetic phase. Moreover, the A_g^4 mode is composed of a series of narrow lines, which diminish above the T_c. We also observed minimal degradation of the flakes in an air-exposed environment, in contrast to the findings reported for 2.3 eV excitation in Ref. [2].

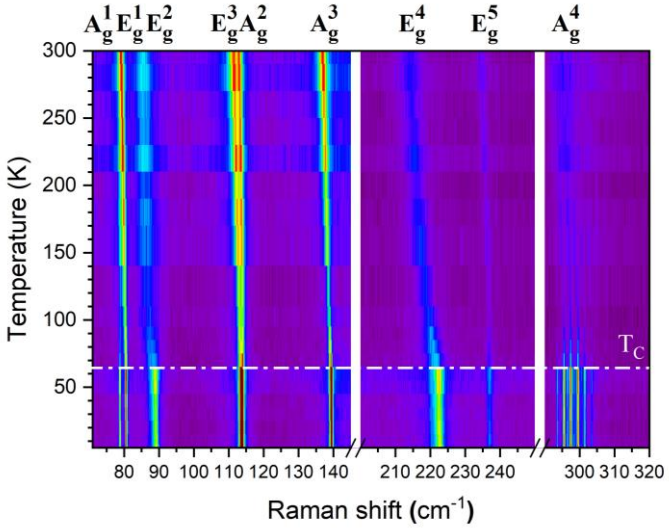

Figure: False-colour map of temperature evolution of the RS spectra measured on $Cr_2Ge_2Te_6$ flake. The T_c value is indicated by horizontal white dashed line.

Our results highlight that the electron-phonon interaction strongly depends on both thickness and degradation, suggesting potential significance for magneto-elastic coupling in magnetic layered materials.

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