Pressure effect on superconductivity in YB_6

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Yttrium hexaboride YB_6 is known as a conventional type-II BCS superconductor with the second highest superconducting transition temperature (T_c < 8 K) among boron compounds after famous MgB_2 ($T_c \approx 40$ K). One of the explanations of this rather high T_c is the strong coupling of electrons with the dominant Einstein-like acoustic mode of Y ions at $\hbar\omega_E \approx 8$ meV [1]. The predicted [2, 3] and observed [4] fast initial decrease in T_c with pressure ($dT_c/dp \approx 0.55$ K/GPa) was attributed to the high Grüneisen parameter of this mode, $\gamma = -\partial \ln\omega_E / \partial \ln V \approx 9$ [2], which represents the change of the circular frequency ω_E with pressure (volume V).

In order to contribute to the elucidation of the pressure effect on the Einstein-like mode, we have investigated the pressure effect on ω_E by Raman scattering up to 14 GPa (see Figure 1). The analysis of our Raman spectra together with previous *ac*-susceptibility measurements of T_c under pressure up to 11 GPa as well as lattice parameter up to 32 GPa [5] are in accordance with the recent experiments [6] as well as calculations [3] and provides new original information about the value of the electron–phonon coupling constant of YB_6 at ambient pressure, λ_0, and its change with pressure, $\lambda(p)$. The pressure effect on the λ calculated from the McMillan–Allen–Dynes expression for the superconducting transition temperature was determined to be $\partial \ln\lambda / \partial \ln V \cong 7.2$.

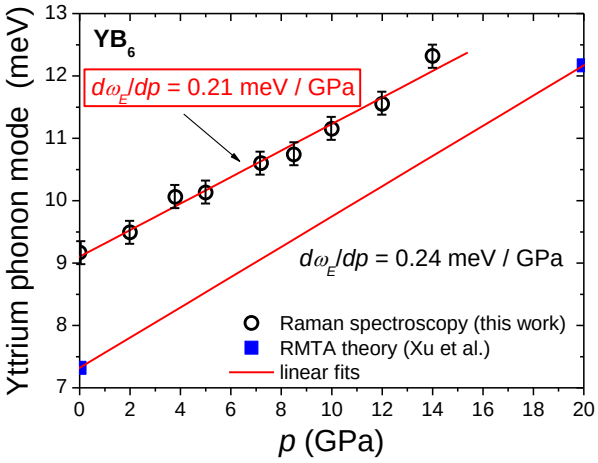

Figure 1. Pressure dependence of the Einstein-like phonon mode energy of yttrium ions in YB_6 received from our Raman spectra (*open circles*), compared with the Rigid-muffin-tin approximation [3] (*solid squares*).

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[1] P. Szabó et al., *Superconducting Science and Technology* 2013, **26,** 045019.
[2] R. Lortz et al., *Physical Review B* 2006, **73,** 024512.
[3] Y. Xu et al., *Physical Review B* 2007, **76,** 214103.
[4] R. Khasanov et al., *Physical Review Letters* 2006, **97,** 157002.
[5] S. Gabani et al., *Physical Review B* 2014, **90,** 045136.
[6] Yu.S. Ponosov, N.Yu. Shitsevalova, JETP Letters 2015, **102**, 295.