Abstract. To examine the Fermi surfaces of the recently discovered quaternery compounds \( \text{RENi}_2\text{B}_2\text{C} \) measurements of the de Haas-van Alphen (dHvA) effect were made on \( \text{YNi}_2\text{B}_2\text{C} \) single crystals in magnetic fields up to 12 T. For \( B \parallel c \) we observe two dHvA frequencies \( F_1 = 0.499 \text{kT} \) and \( F_2 = 6.933 \text{kT} \) which corresponds to approximately 1.5% and 21% of the Brillouin zone cross section area. Both frequencies could be observed deep in the vortex state of the type-II superconductor, the lower dHvA frequency down to 2 T corresponding to roughly 1/5 of the upper critical field \( B_{c2} \) which was found to be 10.6 T in resistivity measurements. The field dependent quasiparticle damping in the superconducting state is very weak, since the amplitude of the dHvA oscillations seems to be unaffected by the phase transition at \( B_{c2} \).

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Recently, several new intermetallic borocarbide superconductors have been discovered with relatively high transition temperatures [1, 2]. The crystal structure of the quaternery system \( \text{RENi}_2\text{B}_2\text{C} \) \( (\text{RE} = \) rare earth element) consists of alternating layers of \( \text{Ni}_2\text{B}_2 \) and \( \text{REC} \), but the superconducting as well as normal state properties of single crystalline \( \text{YNi}_2\text{B}_2\text{C} \) show only weak anisotropies. One of their fascinating features is that superconductivity is observed not only for nonmagnetic rare earth elements, but also for the magnetic ones Dy, Ho; Er and Tm [1, 3]. The competition between superconductivity and magnetism leads to a variety of exotic phenomena caused by the magnetic pair breaking.

Important information on the electronic band structure and the Fermi surface can be obtained from the observation of magnetic quantum oscillations in de Haas-van Alphen (dHvA) experiments. In this note we report on the first observation of the dHvA effect in \( \text{YNi}_2\text{B}_2\text{C} \) in a large magnetic field range above and below \( B_{c2} \).

Single crystals of \( \text{YNi}_2\text{B}_2\text{C} \) were grown by the high temperature flux technique with \( \text{Ni}_2\text{B} \) as flux [4]. The dHvA measurements as well as the transport measurements were performed on the same small platelet shaped single crystal with a mass of about 1 mg. Measurements below 0.35 and 4.2 K have been performed in a \( ^3\text{He} \) bath cryostat which can also be run with \( ^4\text{He} \). The system is equipped with a 12 T superconducting solenoid. The dHvA signal was generated by field modulation as a voltage induced on a pair of compensated pick-up coils and was detected by lock-in technique [5]. The upper critical field was measured resistively in the usual four-point geometry on the same crystal supplied with four thin gold wires.

The temperature dependence of the low-field (0.15 mT) ac-susceptibility is given in Fig. 1. The single crystal shows a sharp superconducting transition at \( T_c = 16.7 \text{ K} \) with a transition width as small as \( \Delta T_c = 0.4 \text{ K} \). The residual resistivity ratio \( RRR \) of the sample was measured to be \( \rho(300 \text{ K})/\rho(17 \text{ K}) = 43 \). As a consequence of the small dimensions of the sample, the geometry of the contacts was not well defined and the absolute resistivity values could not be measured directly. From the room temperature resistivity of larger \( \text{YNi}_2\text{B}_2\text{C} \) samples and \( RRR = 43 \) we obtain a residual resistivity of \( \rho(17 \text{ K}) \approx 2.5 \mu\Omega \text{ cm} \) for the single crystal.

The temperature dependence of the upper critical field \( B_{c2} \) was measured in the temperature region \( 0.35 \text{ K} < T < 4.2 \text{ K} \) for \( B \parallel c \) as midpoint of the resistive transitions in \( \rho(B)T=\text{const} \) to the normal state. The results are shown in Fig. 2. The value \( B_{c2}(0) = 10.6 \text{ T} \) is considerably larger than expected from published \( B_{c2} \)-measurements which were performed on polycrystalline \( \text{YNi}_2\text{B}_2\text{C} \) samples in the temperature range \( 4.2 \text{ K} < T < T_c \) [6, 7, 8]. Extrapolating these data \( B_{c2}(0) \approx 7 \text{ T} \) is obtained. One reason for this discrepancy may be the different zero field transition temperature. The transition temperature of our single crystal is larger than those reported in the above cited references \( (15.0 \text{ K} \) [6], 14.5 K [7] and 15.3 K [8] ). Another reason for the difference may be the unusual temperature dependence of \( B_{c2}(T) \) which makes it difficult to extrapolate to \( B_{c2}(0) \).

From \( B_{c2}(0) = 10.6 \text{ T} \) we obtain the coherence length \( \xi_{0c}(0) = \sqrt{\Phi_0/(2\pi B_{c2}(0))} = 5.5 \text{ nm} \). From the measured
thermodynamic critical field $B_{c2}(0) = 0.248 \, \text{T}$ [9] we get an estimate of the Ginzburg–Landau parameter $\kappa = 27$, regarding the slightly different $T_c$ values by the BCS law of corresponding states.

For $B_c$ two dHvA frequencies were observed in the measurements of $\frac{d\chi}{dB}$ in different magnetic field ranges. Fig. 3a shows the dHvA oscillations in the low field range $2 \, \text{T} < B < 4 \, \text{T}$ with a dHvA frequency of $F_1 = 0.499 \, \text{kT}$. Above $8 \, \text{T}$ the signal is dominated by a second frequency $F_2 = 6.933 \, \text{kT}$ which is shown in Fig. 3b. The decrease of the $F_1$ amplitude at higher fields is caused by the field dependence of the Bessel function $J_2(2\pi F_1 b/B^2)$ which occurs in the field modulation technique. The same frequency $F_2$ is observed both above and below the critical field $B_{c2}$. Figure 4 shows the spectrum obtained by a fast Fourier transform of the data of Fig. 3b. Both frequencies appear as sharp peaks.