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Observation of electronic structure of chiral magnet $GdNi_3Ga_9$ by ARPES

Y. Tanimoto[a], Y. Nakashima[a] H. Sato[b], M. Arita[b], Y. Miyai[a], K. Shimada[c], K. Tanaka[c], S. Nakamura[d], S. Ohara[d]

[a]*Graduate School of Advanced Science and Engineering, Hiroshima University, Higashi-Hiroshima 739-8526, Japan*
[b]*Hiroshima Research Institute for Synchrotron Radiation Science, Higashi-Hiroshima 739-0046, Japan*
[c]*UVSOR synchrotron Facility, Institute for Molecular Science, Okazaki 444-8585, Japan*
[d]*Graduate School of Engineering, Nagoya Institute of Technology, Nagoya 466-8555, Japan*

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Trigonal $GdNi_3Ga_9$ has a chiral crystal structure belonging to space group of *R*32 (No. 155) [1] and is of interest as a 4*f* chiral metallomagnetic compound [2]. The localized Gd 4*f* spins are magnetically ordered below *T*=19.5 K, antiferromagnetic in the *c*-plane, and exhibit left-handed or right-handed helimagnetism with propagation vector $\boldsymbol{q}$=(0, 0, 1.485) [2]. Spin-polarized conduction electrons are thought to be responsible for this phenomenon. $GdNi_3Ga_9$ has the same crystal structure as $YbNi_3Al_9$, which is the first discovered 4*f* chiral metallomagnetic compound [3]. $YbNi_3Al_9$ exhibits a helimagnetism with propagation vector $\boldsymbol{q}$=(0, 0, 0.82), while ferromagnetic order in the *c*-plane in contrast to $GdNi_3Ga_9$ with antiferromagnetic order in the *c*-plane. Therefore a comparative study for $GdNi_3Ga_9$ is expected [3]. We have previously performed angle-resolved photoemission spectroscopy (ARPES) on $YbNi_3Al_9$ and observed five hole-like Fermi surfaces around $\bar{\Gamma}$ point and one electronic Fermi surface around $\bar{K}$ point [5]. In this study, we have performed ARPES on $GdNi_3Ga_9$ to observe the Fermi surface and the band structure of conduction electronic bands near the Fermi level (E_F). The experiments were carried out at BL-1 of Hiroshima Research Institute for Synchrotron Radiation Science (HiSOR) and at BL7U of UVSOR-III synchrotron. Single crystals used for the ARPES measurements were synthesized by the flux-method [2].

Figure 1 shows the ARPES intensity plots of $GdNi_3Ga_9$ measured at $h\nu$=70 eV with *p*-polarized geometry along the $\bar{\Gamma}$-$\bar{K}$ direction of the surface Brillouin zone. Some hole-like bands around the $\bar{\Gamma}$ point were observed. At k_x=1.0 ~ 2.5 Å^{-1}, several convex-downward bands crossing E_F, the M-shaped band and the V-shaped band shown by the yellow dashed lines are observed. The shape of some hole-like bands around the $\bar{\Gamma}$ point is similar to that observed in the ARPES spectrum of $YbNi_3Al_9$. On the other hand, the M-shaped band is not observed in $YbNi_3Al_9$.

Figure 2 shows the Fermi surface of $GdNi_3Ga_9$ measured at $h\nu$=70 eV with *p*-polarized geometry. The horizontal and vertical axes are the wavenumbers (k_x, k_y) along $\bar{\Gamma}$-$\bar{M}$ and $\bar{\Gamma}$-$\bar{K}$directions, respectively. At least two hole-like Fermi surfaces, (A, B), around the $\bar{\Gamma}$ point and one electronic-like Fermi surface were observed. Overall features of the Fermi surfaces are similar to $YbNi_3Al_9$. In addition to these Fermi surfaces, an arc-shaped Fermi surface connecting the electronic-like Fermi surface was observed as shown by dashed lines. This Fermi surface is not observed in $YbNi_3Al_9$.

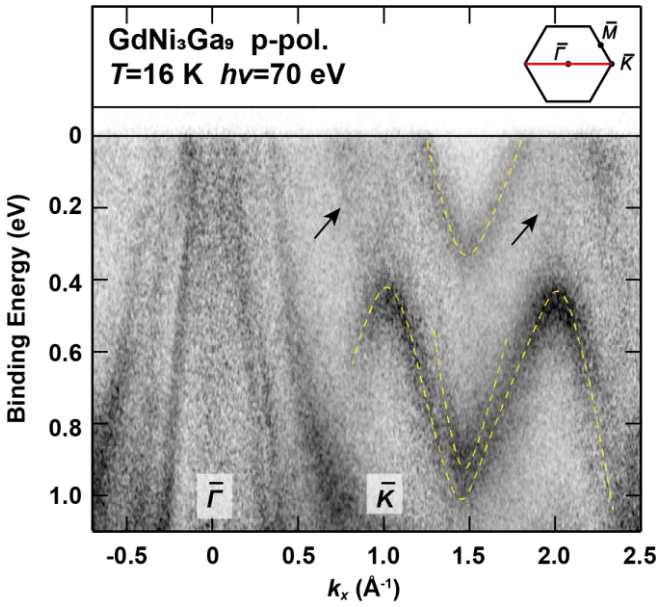

Fig. 1 ARPES intensity plots of $GdNi_3Ga_9$ measured along the $\bar{\Gamma}$-$\bar{K}$ direction and at $h\nu$=70 eV with *p*-polarized geometry.

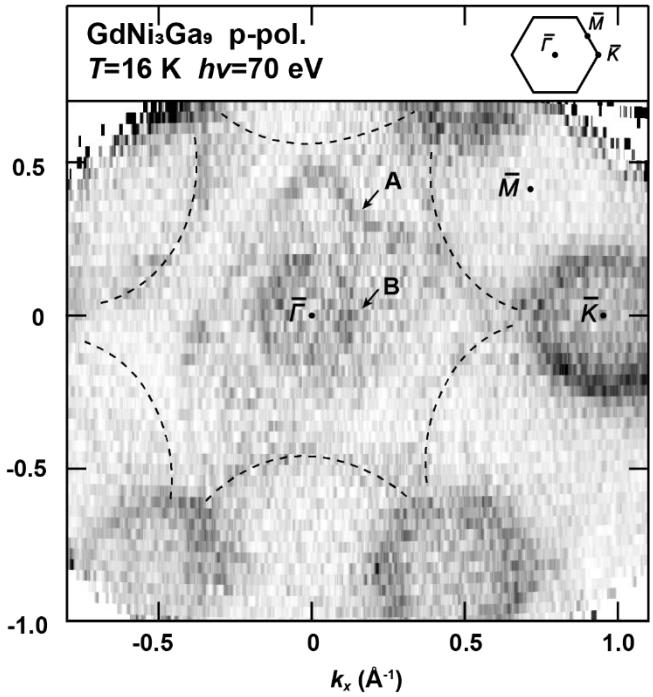

Fig. 2 Fermi surface of $GdNi_3Ga_9$ measured at $h\nu$=70 eV with *p*-polarized geometry.

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