High-pressure study of the charge density wave evolution in $SmNiC_2$

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In the family of rare-earth nickel dicarbides, RNiC$_2$ (R = rare earth), a large variety of different charge density wave (CDW) and magnetic states is observed depending on the incorporated element R. The observed changes in the characteristic charge ordering and its interplay with magnetism upon substitution are partially attributed to the chemical pressure exerted throughout the series of rare-earth elements. Hence, it is of particular interest to investigate the effect of applied hydrostatic pressure on the individual RNiC$_2$ compounds to elucidate the role of pressure within this system.

$SmNiC_2$ exhibits an incommensurate CDW with propagation vector $q_{CDW\text{-}1} = (½, ½+\eta, 0)$, $\eta \approx 0.02$, below $T = 148$ K, evident from X-ray powder diffraction and resistivity measurements [1]. At $T_C = 17.7$ K, $SmNiC_2$ undergoes a first-order phase transition to a ferromagnetic state, coupled to an abrupt suppression of the CDW [1]. This strong interplay of the charge order and magnetic order indicates a weakening of the Fermi surface nesting conditions responsible for the CDW formation in favour of the ferromagnetic ordering [2,3]. The existence of a second, commensurate CDW with $q_{CDW\text{-}2} = (½, ½, ½)$ is implied by diffuse X-ray scattering between room temperature and T_C [1].

To investigate the evolution of the charge ordering in $SmNiC_2$, we have performed single-crystal X-ray diffraction experiments at simultaneously low temperature and high pressure at the European Synchrotron Radiation Facility (ESRF). Our findings evidence the suppression of the well-known incommensurate CDW with $q_{CDW\text{-}1}$ at increased pressures as well as confirm the full formation of the commensurate $q_{CDW\text{-}2}$ CDW as shown in Figure 1. In addition, we observe a new incommensurate CDW with propagation vector $q_{CDW\text{-}3} = (½, ½, \zeta)$, $\zeta \approx 0.06$, coexisting with the other CDW in a region at elevated pressures and low temperature.

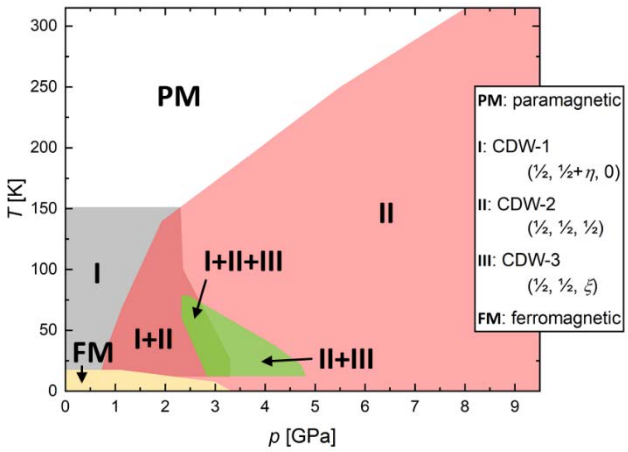

Figure 1. Pressure–temperature phase diagram of the different charge density waves in $SmNiC_2$. The colours indicate the approximate stability fields for the different CDW.

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