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Competition between superconductivity and charge density wave in the quasi-1D compound TTF[Ni(dmit)$_2$]$_2$

Wafa Kaddour[1,2], Claude Pasquier[1], Pascale Auban-Senzier[1], Miguel Monteverde,[1]
Hélène Raffy[1], Samia Charfi-Kaddour[2], Jean-Paul Pouget[1] and Enric Canadell[3]
[1]*Laboratoire de Physique des Solides, Université Paris-Sud, CNRS, UMR 8502, 91405 Orsay, France*
[2]*Laboratoire de Physique de la Matière Condensée, Faculté des Sciences de Tunis, Campus Universitaire, 1060-Tunis, Tunisie*
[3]*Institut de Cincia de Materials de Barcelona, Campus de la UAB, 08193 Bellaterra, Espagne*

Email: claude.pasquier@u-psud.fr

We have revisited the pressure-temperature phase diagram of the quasi-1D organic salt TTF[Ni(dmit)$_2$]$_2$ which is a multi-band compound. At low temperature, a charge density wave (CDW) state was established through X-ray measurements at ambient pressure twenty years ago. However, the system exhibits a metallic behavior without any anomaly at the CDW transition temperature as seen in the resistivity measurements down to the lowest temperatures. This compound is also known to present superconductivity (SC) under an applied pressure of 0.7 GPa at 1.6K, which is a high value for an organic compound with a competition between SC and CDW. Thanks to measurements of longitudinal and transverse resistivities, thermopower and thermal conductivity under pressure up to 3 GPa in a wide range of temperature, we were able to establish a new phase diagram of TTF[Ni(dmit)$_2$]$_2$. First, CDW transitions that exist at ambient pressure merge into only one transition at P=12 kbar preceding a commensurability peak of the transition temperature similar to the one observed in TTF-TCNQ. As far as superconductivity is concerned, it emerges at P =0.2 GPa and the critical temperature, T_c, increases rapidly up to 0.5 GPa then increases smoothly up to 3 GPa. However, a cusp of T_c is observed around P =1.1 GPa. Thanks to DFT calculations, a new image of the band structure, so the Fermi surface, has been calculated at ambient pressure for different temperatures which allows estimating its evolution under pressure. In this presentation, we will try to explain the complex phase diagram of this compound and a tentative explanation of the merging of the CDW transitions and the cusp of T_c will be proposed. Few insights on the nature of superconductivity in TTF[Ni(dmit)$_2$]$_2$will be also presented.