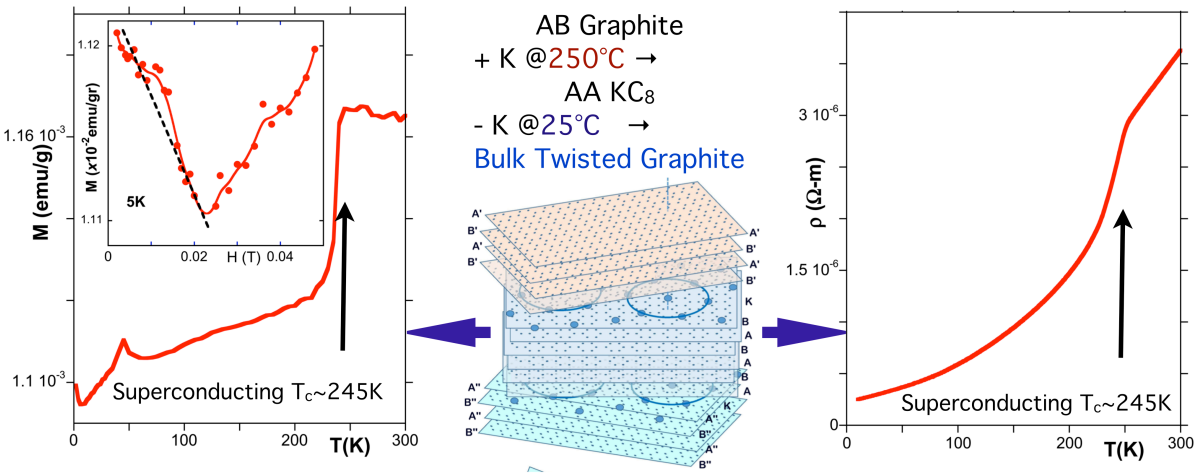
NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2022-2023

Search for the origin of the room temperature superconductivity in bulk twisted graphite

General Scope :

For twenty years there have been claims on the existence of room temperature superconductivity in pure graphite[Adv.Mat.24(2012)5826], that have been attributed to defects of the AB graphene infinite stacking of graphite. On the other hand, superconductivity has also been reported by several groups on graphene Moiré stackings, albeit with a transition temperature Tc at low temperatures[Nature 556(2018)43]. Namely, two graphene layers stacked twisted with a "magic" angle (~1.1°). In this case, the origin has been tracked to the extremely flat electronic bands that appear in these twisted structures leading to what is called flat band superconductivity. Following theoretical predictions to increase the low Tc's, experimentalists increase the number of graphene planes (up to five presently), and also change the stacking angles. However, the number of potential arrangements are uncountable and the samples very difficult to make. We have design a synthesis by intercalation and de-intercalation of highly oriented pyrolithic graphite to fabricate in the same sample as many as possible of twisted and doping configurations. When we measure the obtained samples we verify by synchrotron radiation and Raman measurements that all six-fold stackings are present in the nanocrystals. The magnetization and electrical resistance measurements show superconducting transitions at 110K, 245K and 320K(see figure)[ArXiv2205.09358, Carbon(2022)]. We now know that some crystals develop high temperature superconductivity. The next step is to study samples with different preparations, in order to increase the amount of superconductivity and pin down their exact geometry.



Research topic and facilities available :

The subject of the internship will consist in magnetization and electrical resistivity measurements of the samples synthesized by the Cristaux-Massifs service of the laboratory, under the supervision of M. Nunez-Regueiro. Synchrotron radiation measuremetns will also be made in the ESRF (G. Garbarino) and Raman measurements at IN (M-A. Méasson).

Possible collaboration and networking :

Networking: ANR projet obtained in 2019. Teams of the Néel Institute, Institut Lumière Matière (Lyon), Sorbonne University (Paris).

Possible extension as a PhD : YES

Required skills:

Good knowledge of condensed matter physics, curiosity, taste for delicate experiments

Starting date : october-april 2023

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