Self-assembling of graphitic nanoplatelets

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Layered materials are the fundamental building blocks of two-dimensional (2D) systems with unusual chemical and physical properties with high specific surface areas, that are important for many and different applications, such sensing, catalysis, and energy storage.

In such a context, carbon-based few-layered nanosheets are fascinating materials, but a reliable procedure of fabrication remains a target not yet met.

We report here our preliminary results of recent researches addressed at the production of 2D crystalline structures. The starting material were colloidal dispersions of graphitic nanoflakes obtained from disruption of SWCNT and MWCNT using high-shear mixing and/or treatments in sulfonitric mixtures both at room and high temperature. The nanoflakes, dispersed in aqueous medium or DMF, have been subsequently deposited on Si substrates or TEM grids for related observations. Depending on the process procedures, different kind of re-organization are found to occur, as evidenced by ED, TEM and micro-Raman analysis. The adopted methodology allows indeed to obtain samples characterized by very different interactions between proximal units , giving rise in particular to:

- clustering of platelets with a relatively small 2D extension and random arrangement of polycrystalline graphite-like nanomaterial inside the clusters.
- assembling of nanoflakes into highly ordered (single-crystal) nanosheets with a relatively large (some thousands of nm^2) surface.

In this last case the ED pattern evidences the presence of quasi-singlecrystal material: the fine structure of the ED pattern is characterized by the almost perfect superpositioning of diffraction spots coming from different platelets not perfectly oriented each other. In such a case, the TEM analysis reveals the presence of relatively thin, but extended, nanosheets.The results shows that the assembly processes can be tailored by modulating the disruption treatments and choosing a suitable dispersion medium, in order to produce selectively different forms of self-assembling, from polycrystalline aggregates to highly self-oriented mosaic-like structures, evidencing the possibility to achieve single-crystal platelets.

It is expected that the identification of cooperative mechanisms acting in such systems could help in opening innovative crystallization pathways and give a relevant contribution for nanotechnologies.