Organic molecular materials: insight from low frequency Raman scattering

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Abstract

Organic molecular solids represent an extensive class of multifunctional materials exhibiting a great variety of physical and chemical properties with potential technological interest. Their peculiar properties are a direct consequence of the weak noncovalent *intermolecular* forces and their delicate balance: a change in temperature, the application of pressure, or a small chemical modification may lead to new material properties. Achieving control and prediction of material properties through crystal engineering is a challenging issue which may benefit from low frequency Raman scattering.

In fact, low frequency Raman scattering, involving the excitations of large amplitude *lattice* vibrations, represents a powerful tool to study the intermolecular interactions and dynamics that ultimately define the bulk properties of molecular materials. Low frequency phonon spectra have already been shown their utility in polymorph identification [1], in the study of phase transition [2], in checking for crystalline phase purity [3], and more recently in the study of disorder and electron-phonon interaction in crystalline molecular materials [4].

The most important application of low frequency vibrational spectroscopy in the field will be illustrated.

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[2] "Phenomenology of the neutral-ionic valence instability in mixed stack charge-transfer crystals" M Masino, N Castagnetti, A Girlando, *Crystals* (2017) 7, 108

[3] "Characterization of Phase Purity in Organic Semiconductors by Lattice-Phonon Confocal Raman Mapping: Application to Pentacene" A Brillante, I Bilotti, RG Della Valle, E Venuti, M Masino, A Girlando, *Advanced Materials* (2005) 17, 2549-2553; "Raman identification of polymorphs in pentacene films" A Girlando, M Masino, A Brillante, T Toccoli, S Iannotta, *Crystals* (2016) 6, 41

[4] "Relaxor ferroelectricity in the polar charge-transfer crystal at the neutral-ionic interface" JKH Fischer, G d'Avino, M Masino, F Mezzadri, P Lunkenheimer, ZG Soos, A Girlando, *Physical Review B* (2021) 103, 115104