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Low-dimensional organic ferroelectrics by design

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Low-dimensional functional organic materials are currently the subject of intensive research, due to their unusual, unique or superior electronic properties, and due to their potential applicability in all-organic electronics. Graphene, hexagonal boron nitride, molybdenum sulphide and other transition metal dichalcogenides are popular examples of atomically thin materials that show great promise for various applications. Interestingly, another class of materials, organic ferroelectrics, can also be synthesized as two-dimensional layers and even as one-dimensional chains, retaining their ferroelectric properties while being amenable to great level of structural and properties design, as will be shown in this talk. It is discussed how atomically thin structures of molecules from known hydrogen-bonded room-temperature ferroelectrics can be synthesized on crystalline surfaces through selfassembly. Those structures include 1D molecular chains, 2D homogeneous networks, and 2D cocrystals. Properly designed, cocrystals allow for asymmetric hydrogen bonds, to build materials with a hierarchy of barriers to proton transfer that could in principle exhibit multiple and complex polarization states. First principlses calculations were employed to study polarization behavior at the molecular level. Calculations based on density functional theory predict that polarization reversal in such chains can occur through proton tautomerization, where the substrate appears to determine the height of the barrier to intermolecular transfer of hydrogens along the hydrogen bonds. It is predicted that hydrogen-bonded organic ferroelectrics can be engineered into 2D and 1D structures while not only retaining their ferroelectric functionality, moreover, the substrate can act as an additional control parameter to control the ferroelectric properties.

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Valorization of agro-food residues for the synthesis of biomaterials for industrial applications

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The need to both avoid waste and find new renewable resources has led to a new and promising research avenue: The use of food supply chain waste (FSC) as a renewable biorefinery feedstock. Residues produced by the FSC contain valuable functionalised molecules, such as flavonoids, waxes, biopolymers, fatty acids or lignocellulosic materials with potential to be used as chemicals to be used as bioadditives and building blocks for biopolymers. The main current uses of the food supply chain, agricultural and forestry residues are low value-added, mainly meeting needs that concern farming activities (bed and feed for livestocks), soil fertilization and compensation (composting) or energetic requirements (pellets for combustion). These uses do not cover the real potential of this feedstock from technologic and profitability points of view. The incorporation of natural additives in a variety of commercialized products depicts the current trend for the limitation of the use of synthetic substances. Many industrial sectors are currently focused on the utilization of functional biomolecules in order to offer advance, more economic and more eco-friendly products. Due to their abundance and renewability, there has been a great deal of interest in utilizing lignocellulosic wastes for the production and recovery of many value-added products such as nanocellulose. This presentation will give a general overview of the current situation of the valorization of FSC to yield high value biomaterials with potential in key industrial sectors, such as food packaging, biomedical, nutraceutical food, cosmetics and many others.

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