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Unlocking the Potential: The Fascinating World of Perovskite Mesocrystals

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THE STUDY OF PEROVSKITE MESOCRYSTAL-GROWTH

In the history of scientific discovery, few minerals have captivated the imagination quite like perovskite. Originating from the depths of Russia's Ural mountains in 1839, this compound, comprised of calcium titanium oxide ($CaTiO_3$), was named in honor of the Russian mineralogist L.A. Perovski. Its crystal lattice, arranged in an ABX_3 format, where A and B represent positively charged ions and X denotes a negatively charged ion, attracted researchers with promises of materialistic wonders beyond its own composition.

Fast forward to the beginning of the 21st century, and the scientific scene witnessed the emergence of mesocrystals. Defined by their parallel crystallographic alignment of small crystals, these structures possess properties that excel beyond the sum of their individual microscopic components. Their orderly arrangement resulting in promising properties, particularly in areas such as electronics and biomedical materials, offering the possibility for innovation and exploration.

But what if these two phenomenons were to join forces? Enter the field of perovskite nanocrystals, where the principles of self-assembly come into play. This process, characterized by the autonomous arrangement of nanoscale perovskite structures into larger, mesocrystalline architectures, opens up new prospects in material science. Through accurate handling of intermolecular forces, researchers initiate the growth of these structures, unlocking new pathways for exploration and application.

The significance of this union goes far beyond the confines of the laboratory. In the field of optoelectronics, where the manipulation of light on a quantum scale is the driving force for progression, perovskite nanocrystals has become important aspects. Metal halide perovskites, such as cesium lead halide ($CsPbX_3$), exhibit near-perfect photoluminescence efficiency and remarkable defect tolerance, offering unprecedented potential for the development of next-generation electronic devices.

Yet, the journey towards tackling the full potential of perovskite mesocrystals is full of challenges. Figuring out the complexity of their self-assembly process requires a complicated approach, combining analytical techniques with theoretical understandings. X-ray diffraction (XRD) serves as a cornerstone, providing extremely valuable information about the atomic structure of these materials. Meanwhile, a synchrotron-based small-angle and wide-angle X-ray scattering combination (SAXS and WAXS), offers much insight into the dynamic evolution of nanocrystals as they grow and align into mesocrystalline structures.

The outcome of these scientific aspirations hold great promise across a wide range of scientific and technological domains. From advancements in semiconductor electronics to breakthroughs in solar energy harvesting, perovskite mesocrystals lead the way for a future destined with efficiency, reliability, and sustainability. As researchers continue to explore the depths of their potential, one thing remains clear: the merger of structure and potential comprised by perovskite mesocrystals signals a new era of scientific discovery and innovation.