ATUM-SEM: Advancing Comprehensive Multi-Scale Analysis in Nanotechnology

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In the current scientific landscape, advanced high-resolution 3D imaging techniques play a pivotal role in unravelling the intricate hierarchical structures of target structures down to the nanoscale. Previously, obtaining images of tissue sections was a time-consuming and error-prone task, which involved manual cutting and handling a large number of slices, followed by individually imaging each section using transmission or scanning electron microscopy.
This research focuses on the innovative application of the Automated Tape-Collecting Ultramicrotome Scanning Electron Microscope (ATUM-SEM), a SEM-based volume imaging technique that offers enhanced z-resolution and high-throughput capabilities. By automating the collection of serial sections, ATUM-SEM overcomes the laborious and error-prone manual processes associated with conventional TEM-based vEM techniques. This cutting-edge method enables faster, more reliable acquisition of large-area serial images, facilitating detailed multi-scale analyses. One of the key advantages of ATUM-SEM is its non-destructive nature, allowing for the preservation of wide sections for post-staining, labelling, and re-imaging under different conditions. This approach provides a comprehensive understanding of the structure-function relationships in complex hierarchical specimens, ultimately leading to more accurate investigations and insights. Case studies demonstrating the effectiveness of ATUM-SEM in various domains are discussed, showcasing its potential to drive innovation and enhance our understanding of nanometer-scale structures across material science, biotechnology, and nanotechnology disciplines.