New X-ray imaging technique visualises teeth’s nanostructures

With the help of a new computed tomography (CT) method that is based on the scattering of X-rays, a team of international researchers has been able to visualise nanostructures in objects measuring just a few millimetres for the first time.

To demonstrate the potential of the technique, the researchers reconstructed the precise 3-D orientation of collagen fibres in a piece of human tooth.

The new method, which was developed by a team of researchers from Technische Universität München (TUM), the Charité hospital in Berlin, Lund University and the Paul Scherrer Institute in Switzerland, utilises the scattering of X-rays rather than their absorption.

Conventional CT methods calculate exactly one value, known as a voxel, for each 3-D image point within an object. The advantage of the new technique is that it assigns multiple values to each voxel, as the scattered light arrives from various directions.

"Thanks to this additional information, we’re able to learn a great deal more about the nanostructure of an object than with conventional CT methods. By indirectly measuring scattered X-rays, we can now visualise minute structures that are too small for direct spatial resolution," explained Prof. Franz Pfeiffer, head of the Institute of Biomedical Physics at TUM.

By combining 3-D information from scattered X-rays with CT, the researchers were able to view clearly the 3-D orientation of collagen fibres in a piece of human tooth measuring around 3 mm. In order to do so, 1.4 million scatter images were taken and then processed using a specially developed algorithm that builds up a complete reconstruction.

"A sophisticated CT method is still more suitable for examining large objects. However, our new method makes it possible to visualise structures in the nanometer range in millimeter-sized objects at this level of precision for the first time," said Florian Schaff, a PhD student at the institute and lead author of the paper.

The new imaging technique could be of interest for the characterisation of not only biomaterials such as bone and teeth, but also functional materials such as fuel cell and battery components, the researchers believe.

The results of the study were published online on 19 November in the Nature journal in an article titled "Six-dimensional real and reciprocal space small-angle X-ray scattering tomography."

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行業新聞 _Imaging technique

全國首次 X 射線成像技術，首次顯示納米結構

科研人員利用一種新的 computed tomography (CT) 方法，基於 X 射線的散射，首次能夠在幾毫米的物體上視覺化納米結構。

為此目的，研究人員重新構建了人類牙齒中 collagen 細胞的準確 3-D 取向。

該新方法，是由一個研究小組從技術大學慕尼黑（TUM）、柏林的 Charité 医院、隆德大學和瑞士的 Paul Scherrer 院所，在發明，利用散射 X 射線而非其吸收。

傳統的 CT 方法計算出一個 3-D 空間內的空間，以稱為一個像素，對於每一點。新方法的優點是它能將多個值分配給每個像素，因為散射的光從不同方向到來。

"多亏了這些額外的資訊，我們才能夠學到更多關於納米結構的東西，而不是傳統的 CT 方法。" TUM 的生物醫學物理研究所所長 Franz Pfeiffer 教授表示。

通過結合 3-D 信息和 CT，研究人員能夠看到人類牙齒中 collagen 細胞的 3-D 取向。要達成此目標，研究人員拍攝了 140 萬張散射圖像，然後使用特別開發的算法組建出完整的重建。

"一種先進的 CT 方法仍然適合於檢查大型物件。然而，我們的新方法使得有可能在毫米級的小物件上以這種精確度首次顯示納米結構。" 施瓦德博士表示。

這種新的成像技術可對生物材料，如骨頭和牙齒，以及功能性材料，如燃料電池和電池元件，都非常重要。

這項研究的結果於 11 月 19 日在自然期刊上發布，在文章標題 "六維實時和共軌空間小角度 X 射線散射成像技術"。

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