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電子線トモグラフィによるポリマー自己集合構造の3次元構造解析

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Three-Dimensional Visualization and Characterization of Polymeric Self-Assemblies by Transmission Electron Microtomography

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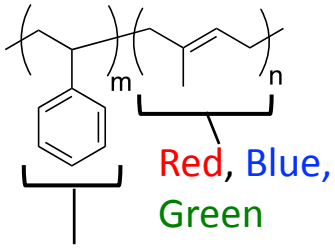
Poly(styrene-*b*-isoprene) (SI)



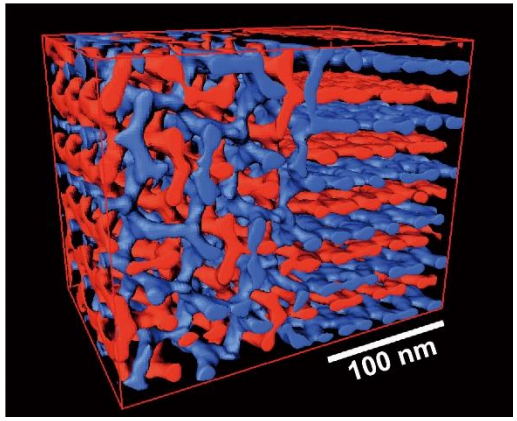


Fig. 1 3D structure of SI during morphological transition from perforated lamella (right) to double gyroid (left).

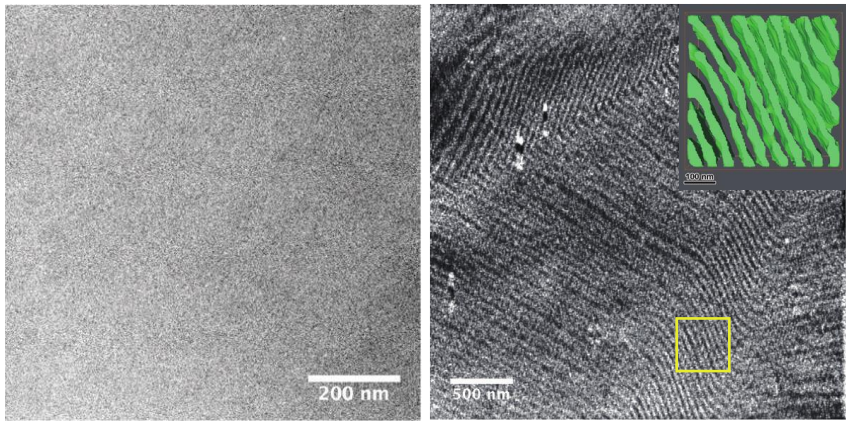


Fig. 2 Conventional TEM image of unstained SI film (left) and reconstructed image from STEM tilt series by TVR-DART algorithms (right).

ブロック共重合体(BCP)の自己組織化における可逆的な秩序−秩序相転移(OOT)に着目し、転移途中の構造を強制的に固定化し、電子線トモグラフィー法（3D-TEM）を適用することで、転移の動的過程を明らかにすることに成功した。また、OOTにおいて構造転移のダイナミクスが転移の方向により異なることを見出した。さらに、動的な構造変化の「その場観察」を目指して、従来の染色法を用いないコントラスト発生技術を開発し、最新の再構成アルゴリズムと組み合わせることで、BCPのミクロ相分離構造を無染色で3次元構造観察することに成功した。

Self-assembling structures and their dynamical processes in block copolymers (BCPs) have been investigated using transmission electron microtomography (3D-TEM). 3D-TEM was applied to an order-order transition of microphase-separated structures, revealing there were two different phase transition paths depending on the direction of transition. Furthermore, we have developed a novel imaging technique for unstained polymeric specimens to enhance image contrast, which was then used together with a new reconstruction algorithm to generate 3D images. This novel imaging technique (for unstained specimens) will open up a new route to “in-situ” nano-observations of the dynamic processes in BCPs.