Studying materials at the border between order and disorder

Espen D. Bøjesen[1,2], Andrew V. Martin[3], Amelia Liu[4] and Timothy C. Petersen[2]

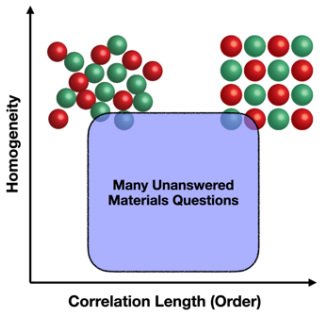
[1]*Interdisciplinary Nanoscience Center, Aarhus University, 8000 Aarhus C, Denmark*
[2]*Monash Centre for Electron Microscopy, Monash University, Clayton 3800 VIC, Australia*
[3]*School of Science, RMIT University, Melbourne 3001VIC, Australia*
[4]*School of Physics and Astronomy, Monash University, Clayton 3800 VIC, Australia*

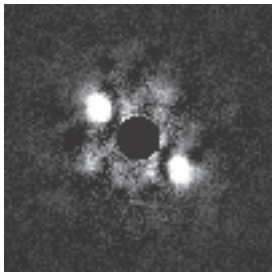
Corresponding author: espen.bojesen@inano.au.dk

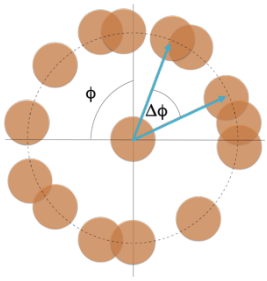
Established methods for the determination of crystal structures have been an unprecedented success in advancing knowledge in the field of materials science. Yet, crucial structure-function relationships cannot be elucidated for many important materials of technological and scientific interest that "occupy the complex middle ground between liquid-like randomness and crystalline periodic order".[1] Isolated, neither the average structure obtained by X-ray diffraction nor atomic-level detailed information from conventional (scanning) transmission electron microscopy ((S)TEM) is sufficient to unlock the structural complexity of such materials. Consequently, new methods to do just that need to be developed.

In this talk I will present selected recent progress in our work focused on developing new scanning electron nanobeam diffraction (SEND)-based methods to study amorphous and highly disordered solids. I will introduce our, by now, well-established approach to local symmetry analysis of SEND data and present recent progress involving the exploration of new statistical measures for studies of amorphous and highly disordered solids.[2] Furthermore, I will present the concepts of the novel pair angle distribution function (PADF) analysis approach by showcasing our successful proof-of-concept study of differently activated carbon samples.[3,4] Here, PADF analysis provided direct evidence of a range of different defects, which enabled us to obtain a more subtle understanding of the structural changes along the activation pathway than what was previously possible by methods, such as, helium pycnometry, EELS, X-ray diffraction and fluctuation electron microscopy.[5]

Finally, I will touch upon the untapped potential of combining state-of-the-art 4D-STEM and total X-ray scattering techniques for studies of a plethora of different materials problems.







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