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DCM characterization of material micro-structures with multi-energy synchrotron X-ray CT

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Quantitative and sample-non-destructive (SND) characterization of 3D microscopic composition distribution in materials is important in a broad range of R&D disciplines. The X-ray CT and image threshold segmentation approach has been widely used. Nevertheless, it imposes a length-scale cut-off at the X-ray CT resolution limit, which would limit its usefulness for materials with multi-length-scale structures beyond the CT imaging resolution range.

By integrating statistical physics and synchrotron-based multi-energy quantitative X-ray CT, the data-constrained modelling (DCM) method (http://en.wikipedia.org/wiki/Data_constrained_modelling) can explicitly reconstructs material microscopic distributions of materials in 3D which incorporates fine spatial structures below X-ray CT image resolution as voxel compositional partial volumes. Consequently, the fine length-scale information below the image pixel size is preserved. Such true micro-structure analysis enables more accurate modelling of material properties. The DCM methodology and its applications will be presented in relation to advanced materials science, oil & gas reservoir characterizations, and micro-structure-based material properties modelling.

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