Simulating the Effect of Porosity on Properties of Synthetic Graphite

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Synthetic graphite materials are technologically-important engineering materials that are critical for high-temperature applications such as gas-cooled nuclear reactors and metal processing.

However, porosity is inherent in synthetic graphite due to raw materials and processing. For example, commercial synthetic graphite grades are often 20% less dense than expected for theoretical graphite. The pore structure geometry of graphite is complex, comprised of both open and closed pores at various length scales. Therefore, it is a challenge to simulate the effect of the pore structure on properties using methods such as finite element modeling.

Most finite element modeling assumes a homogenous material, due to the complexity of incorporating non-homogenous features such as porosity. This talk with present the results of two 3D finite element models of coarse-grained synthetic graphite; models were constructed to include porosity captured from X-ray micro-tomography scans. The process includes obtaining the high-resolution scans, segmenting the scans into pores and solid, meshing the solid, applying material property and boundary conditions, and solving the model. Simpleware ScanIP and COMSOL software programs were used. Although the simulated pores are numerical approximations of the real pores, the models show the stress concentration effect of the pores in 3D, as well as the influence of the porosity on the crack path as compared to the actual tested sample. Differences between a homogenous model approach and the heterogeneous model with pores will be highlighted, including compromises between simplicity and realism.