C10: Numerical investigation of the liberation of critical raw materials in the form of Engineered Artificial Minerals (EnAMs) from tailored solidified slag phases by DEM-based comminution

Contact: Paul Hirschberger, p.hirschberger@tu-berlin.de
Prof. Dr.-Ing. Harald Kruggel-Emden, kruggel-emden@tu-berlin.de

Overview

Among minerals, metals and natural materials those raw materials that are most important economically and have a high supply risk are called critical raw materials. Critical raw materials are essential to the functioning and integrity of a wide range of industrial branches, which requires on the one hand a diversified and undistorted access to global markets for them. On the other hand, increased availability can be achieved by reducing, reusing and recycling the critical raw materials, but also by finding new sources for them.

Possible new sources for critical raw materials, yet mostly not exploited, are solidified slag systems from pyrometallurgical processes. In these systems it is usually aimed for the main metal phase. All other materials are driven into the slag phase, which becomes a carrier of a broad number of valuable elements. When the slag solidifies it can generate crystals, which can be seen as artificial minerals referred to as Engineered Artificial Minerals (EnAMs) in which the valuable elements are enriched. In order to further process the EnAMs, they need to be liberated by comminution and are often separated as particles.

Goals

Overall aim of the proposed research work is to contribute to the prediction of EnAM liberation from slag systems by utilizing Discrete Element Method (DEM) modelling. This requires to model both comminution in the sense of size reduction accompanied by liberation. To include the latter run-time efficient in the DEM, the particle replacement method (PRM) is used. As it is yet not fully clear if random or non-random breakage is the dominant breakage mode to govern comminution of EnAM containing slags, the hypothesis that it is governed mostly by random breakage is pursued as part of the first funding period of SPP 2315. Random breakage is thereby understood in the sense that breakage is not texture dependent – the dependence on composition is however realized for. At a later stage, the DEM modelling framework can be extended to include also non-random texture dependent breakage, if this proofs to be relevant.

Throughout the first funding period of SPP 2315 a modeling framework will be developed that will cover various loading conditions. The framework will be calibrated to at least one EnAM containing slag system as considered throughout SPP 2315. For details on the modelling framework see Figure 1.

By applying the calibrated framework to laboratory-scale comminution apparatuses and a benchmarking against experimental data on obtained size distributions and liberation degrees, it will be ensured that the DEM can be applied to complex slag systems containing EnAMs. This allows to utilize the predictive capabilities of the DEM to analyze on optimal interconnections of comminution processes for EnAM liberation from slags as a second step.

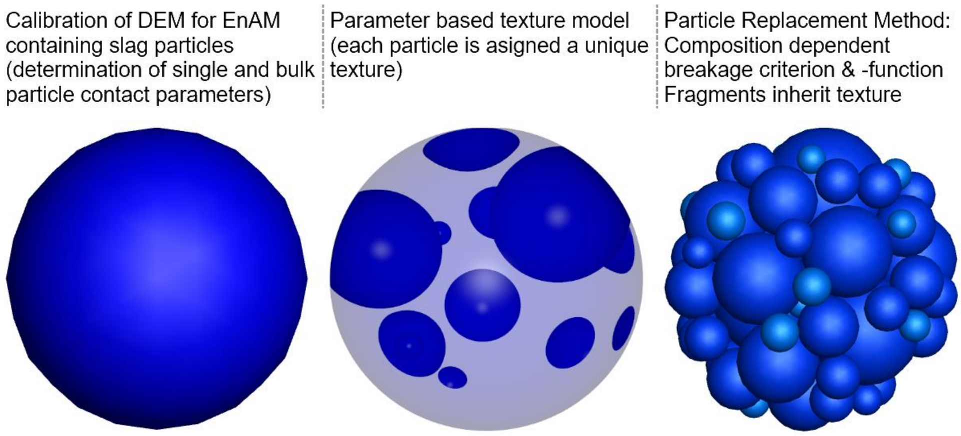

Figure 1: Schematic representation of the modelling framework for the composition dependent Particle Replacement Method (PRM) in the DEM