Practically occurring processes of colloidal aggregates’ production and their processing in sheared fluids involve the preparation of aggregates made of a large number of particles. Population balance equations (PBE), implementing aggregation and breakage kinetics, are commonly used to investigate and predict the evolution of aggregate formation under different conditions. However, PBE require lumped parameters, called kernels for both aggregation and breakage processes, to include all the physical information about the process. In the literature, the aggregation kernels are generally well established, whereas the breakage kernels hold a great degree of uncertainty as the aggregate breakup process is significantly more complex to study both experimentally and computationally.

We have formulated a model to study the breakup of colloidal aggregates made of identical spherical particles in shear flow under laminar flow conditions, using Stokesian dynamics to estimate the hydrodynamic interactions among the particles, DLVO theory to describe the normal inter-particle interactions, and discrete element method to account for the tangential contact interactions. Simulations were performed to study different characteristics of the breakage process of fractal aggregates, generated using different Monte-Carlo methods, composed of a number of uniform sized spheres and characterized by fractal dimensions, at different flow magnitudes in simple shear flow. The developed model was first used to investigate the dependence of the characteristic time required for the onset of cluster breakage on the cluster geometry (mass and morphology) and flow conditions. In addition, the dependence of the fragment mass distribution at the instance of first breakage on the cluster mass and morphology has been studied. The so performed analysis of the breakage process was used to develop a breakage kernel which can be directly used in PBE.