

A tribute to Marian Smoluchowski's legacy on colloid type matter aggregation, and related issues

Monday, 4 September 2017 14:30 (30 minutes)

In 1916 Marian Smoluchowski proposed a case of constant-kernel cluster cluster aggregation, for which it is manageable to find analytically by employing scaling arguments, a solution in terms of the cluster size (k) distribution function, $n(k)$ [1,2].

By applying this scaling function it is then possible to get, within the long times' limit, the results for the mean cluster size $\{k\}$ and the total number of the clusters N , both scalable in terms of time t with a single exponent, g [2].

The clustering arguments, first introduced by Smoluchowski [1], are easily applicable to statistical description of physical-metallurgical processes and ceramic-polycrystalline evolutions, termed the normal grain growth, in which bigger clusters grow at the expense of their smaller neighboring counterparts due to capillary conditions [3].

The normal grain growth, and its dynamics, can be expressed in d -dimensional space (d - Euclidean dimension of the space). Upon identifying $\{k\}$ from the Smoluchowski description with $\{R\}$, the mean cluster radius' size from the normal grain growth approach, and by taking the "extreme" condition of $k \gg 0$, one is able to embark on their equivalence by stating rigorously that $g=1/(d+1)$, since the asymptotic scaling rule for N (here: the number of grains) goes via a simple logarithmic depiction as: $\ln[N] \sim \ln[g]$.

The crucial assumption, however, that assures the equivalence claimed, appears to be fully feasible when re-arranging the time domain by substituting t in a way such that a new rescaled time variable $T(t)$ is given by a definite integral in $[0,t]$ upon $dT(t)=dt/f(t)$, with an adjustable function f , coming from the dispersive or long-tail, or fractal kinetics' arguments [4].

The arguments may at least qualitatively concern biomembranes dynamics; they can also contribute to nucleation-growth processes in (psychodynamic-clustering) living matter conditions [5-7].

[1] M. von Smoluchowski, *Physikalische Zeitschrift* **17**, 585 (1916).

[2] R. Jullien, *Croatica Chemica Acta* **65**(2), pp. 215-235 (1992).

[3] P.A. Mulheran, J.H. Harding, *Materials Science Forum* **94-96**, pp. 367-372, 1992.

[4] A. Plonka, *Dispersive Kinetics*, Kluwer, Dordrecht, 2002.

[5] A. Gadowski, A. Gadowski, *European Physical Journal B* **9**, 569 - 571 (1999).

[6] A. Gadowski, M. Ausloos, T. Casey, *Nonlinear Dynamics in Psychology & Life Sciences* **21**/2, 129-141 (2017).

[7] A. Gadowski, *Philosophical Magazine Letters* **70**, 335 (1994).

Primary author: GADOMSKI, Adam (UTP University of Science and Technology Bydgoszcz, Poland)

Co-author: AUSLOOS, Marcel (GRAPES, Liège, Belgium & University of Leicester, UK)

Presenter: GADOMSKI, Adam (UTP University of Science and Technology Bydgoszcz, Poland)

Session Classification: Session 2