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Kinetic Behavior of Exchange-Driven Growth with Catalyzed-Birth Processes

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Abstract: Two catalyzed-birth models of n-species (n≥2) aggregates with exchange-driven growth processes are proposed and compared. In the first one, the exchange reaction occurs between any two aggregates A_k^m and A_j^m of the same species with the rate kernels $K_m(k,j)=K_m kj$ (m=1,2,...,n, n≥2), and aggregates of A^n species catalyze a monomer-birth of A^l species (l=1,2,..., n-1) with the catalysis rate kernel $J_l(k,j)=J_l k j^{\upsilon}$. The kinetic behaviors are investigated by means of the mean-field theory. We find that the evolution behavior of aggregate-size distribution $a_k^l(t)$ of A^l species depends crucially on the value of the catalysis rate parameter υ: (i) $a_k^l(t)$ obeys the conventional scaling law in the case of $\upsilon\leq 0$, (ii) $a_k^l(t)$ satisfies a modified scaling form in the case of $\upsilon>0$. In the second model, the mechanism of monomer-birth of A^n-species catalyzed by A^l species is added on the basis of the first model, that is, the aggregates of A^l and A^n species catalyze each other to cause monomer-birth. The kinetic behaviors of A^l and A^n species are found to fall into two categories for the different υ: (i) growth obeying conventional scaling form with $\upsilon\leq 0$, (ii) gelling at finite time with $\upsilon>0$.

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