The formation of astrophysical Mg-rich silicate dust

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I will present results for ground-state candidate energies of Mg-rich olivine (MRO) clusters and use the binding energies of these clusters, and determine their nucleation rates in stellar outflows, with particular interest in the environments of core-collapse supernovae (CCSNe). Low-lying structures of clusters $(Mg_2SiO_4)_n$ $2 \leq n \leq 13$ are determined from a modified minima hopping algorithm using an empirical silicate potential in the Buckingham form. These configurations are further refined and optimized using the density functional theory code Quantum Espresso. Utilizing atomistic nucleation theory, we determine the critical size and nucleation rates of these clusters. We find that configurations and binding energies in this regime are very dissimilar from those of the bulk lattice. Clusters grow with SiO_4-MgO layering and exhibit only global, rather than local, symmetries. When compared to classical nucleation theory we find suppressed nucleation rates at most temperatures and pressures, with enhanced nucleation rates at very large pressures. This implies a slower progression of silicate dust formation in stellar environments than previously assumed.