

Circumstellar dust shells around oxygen-rich long-period variable stars

K. S. Jeong, J. M. Winters, E. Sedlmayr
Institut für Astronomie und Astrophysik, TU Berlin

We present a consistent model for circumstellar dust shells (CDS) around O-rich long-period variable stars (LPVs). Since almost all carbon is locked up in the chemically inert CO molecule in an O-rich environment, the grains only can be formed from molecules containing the remaining oxygen and the less abundant elements Mg, Si, S, Fe, Al, Ti. This leads to a heterogeneous element composition of the emerging dust component. Assuming chemical equilibrium in the gas phase, we describe the formation of the seed particles by means of a modified classical nucleation theory. The most promising seed nuclei appear to be TiO_2 clusters, which grow by addition of those molecular species which have a stable solid phase under the local thermodynamic conditions prevailing in the CDS. For calculating the nucleation rates, the Gibbs free energies of Ti_xO_y clusters are used, resulting from quantum mechanical Density Functional Theory calculations of their structures. We present the results of a consistent dust shell model characterised by $L_* = 2.10^4 L_\odot$, $T_* = 2000\text{K}$, $M_* = 1 M_\odot$, $\Delta u_p = 5 \text{ km s}^{-1}$, $P = 300\text{d}$, and solar element composition. This model produces a mass loss rate of $\dot{M} \sim 5.10^{-5} M_\odot/\text{yr}$ and an outflow velocity of $v_\infty \sim 15 \text{ km s}^{-1}$. The radii of most of the dust grains range between 0.01 and 0.1 μm . The chemical composition and temporal evolution of the resulting dust grains and their influence on the generation of massive outflows from oxygen-rich LPVs will be discussed.