We present a multiscale model of laser-solid interactions in silicon based on an empirical potential developed under conditions of strong electronic excitations. The parameters of the interatomic potential depends on the temperature of the electronic subsystem $T_e$, which is directly related to the density of the electron-hole pairs and hence the number of broken bonds. We analyze the dynamics of this potential as a function of electronic temperature $T_e$ and lattice temperature $T_{on}$. The potential predicts phonon spectra in good agreement with finite-temperature density-functional theory (DFT), including the lattice instability induced by the high electronic excitations. For 25fs pulse, a wide range of fluence values is simulated resulting in heterogeneous melting, homogenous melting, and ablation. The results presented demonstrate that phase transitions can usually be described by ordinary thermal processes even when the electronic temperature $T_e$ is much greater than the lattice temperature $T_L$ during the transition. However, the evolution of the system and details of the phase transitions depend strongly on $T_e$ and corresponding density of broken bonds. For high enough laser fluence, homogeneous melting is followed by rapid expansion of the superheated liquid and ablation. Rapid expansion of the superheated liquid occurs partly due to the high pressures generated by a high density of broken bonds. As a result, the system is readily driven into the liquid-vapor coexistence region, which initiates phase explosion. The results strongly indicates that phase explosion, generally thought of as an ordinary thermal process, can occur even under strong nonequilibrium conditions when $T_e >> T_L$. In summary, a detailed investigation of laser-solid interactions in silicon is presented for femtosecond laser pulse that yield strong far-from-equilibrium conditions.