

Casting metal oxide nanoparticle size via temperature-controlled coarsening: A novelty in model picture

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The present study aims to discuss the coarsening process of freshly precipitated metal oxide nanoparticles (NPs) via short time (1-2 hours) hydrothermal treatment in mild temperature (T) range (100 to 300 °C). Transmission electron microscopy data can be used to assess the average particle diameter (D_T) of both the as-precipitated NPs and the hydrothermally treated samples at increasing temperatures. Surprisingly, the D_T versus T trend can follow a sub-linear, a linear or a super-linear behavior, depending upon the condition the diffusion process is set to take place during coarsening and the characteristics of the species diffusing in the medium. Experimental data showing different D_T versus T trends (sub-linear, linear, or super-linear) will be presented and discussed based on a physical model picture for the underlying coarsening process, which takes into account diffusion of species *in* and *out* of the NP. Moreover, the model picture predicts the limits for the sub-linear as well as the super-linear D_T versus T behavior; the former sets in as long as the thermal activated diffusion process is dominant whereas the latter may be observed for higher diffusivity values. The linear trend can be observed either in a competitive scenario involving the two above-mentioned limits (dominant thermal activated diffusion process and at higher diffusivity values) or in the absence of them. Within the limits of the model picture a linear relationship between D_T and t (coarsening time) was found, accounting for both Lifshitz and Slyozov and Wagner coarsening models (introduced in early 1960's) at relatively short times.

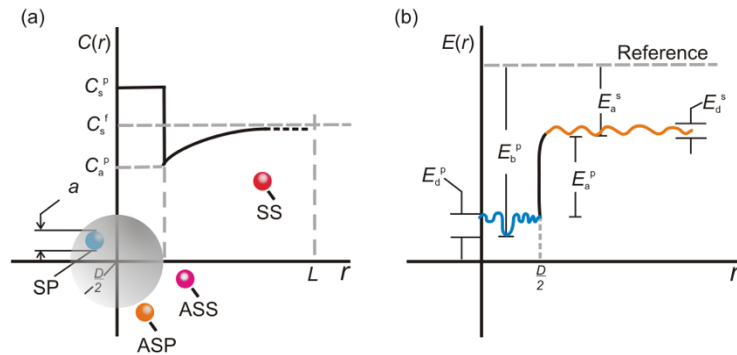


Figure (a) Represents the concentration of species, $C(r)$, at increasing distance (r) from the NP of diameter D (ASP: adspecies in the NP at concentration C_a^p ; ASS: adspecies in suspension at concentration C_s^p ; SS: species in suspension at concentration C_s^f). (b) Represents the energetics (E_b^p , E_a^p , and E_d^p) of the species with respect to a reference as well as the diffusion energy barrier of SS to become ASS (E_d^s) and ASS to become ASP (E_a^p).

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