The role of bound water in the process of low-temperature oxidation of aluminum powders

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The composition of the superficial (hydr)oxide shells of Al particles

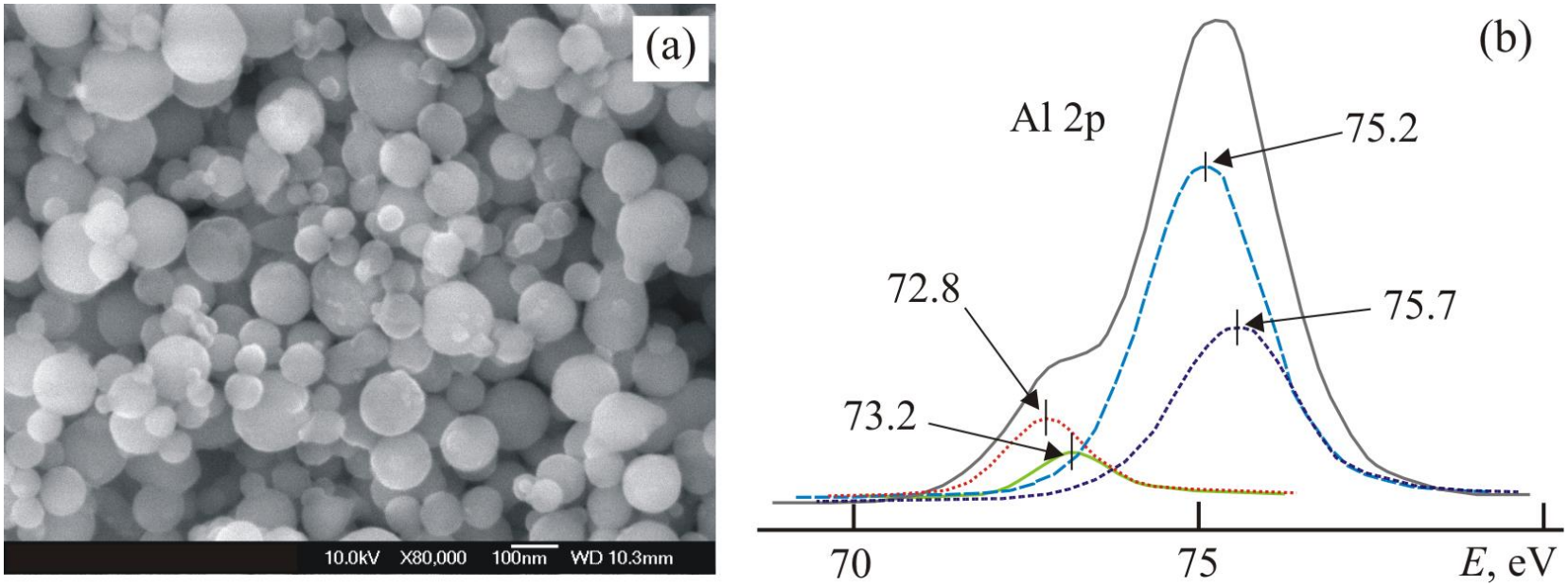

Figure 1. (a) SEM image and **(b)** a fragment of the XPS spectrum of Al powder particles "Alex"

In the fragment of the XPS spectrum corresponding to the binding energies of Al2p, the peak deconvolution revealed peaks with binding energies of 72.8 eV (Al2p3/2) and 73.2 eV (Al2p1/2) in metallic Al, as well as 75.2 and 75.7 eV related to oxide (close to the binding energy in γ-Al_2O_3) and Al hydroxide, respectively. The value of Al2p 75.7 eV is intermediate between 76.6 eV (AlOOH) and 75.8 eV (trihydroxide) and characterizes partially dehydrated $Al(OH)_3$ formed under conditions of the XPS high vacuum [7].

Linear heating of Al powders in air atmosphere

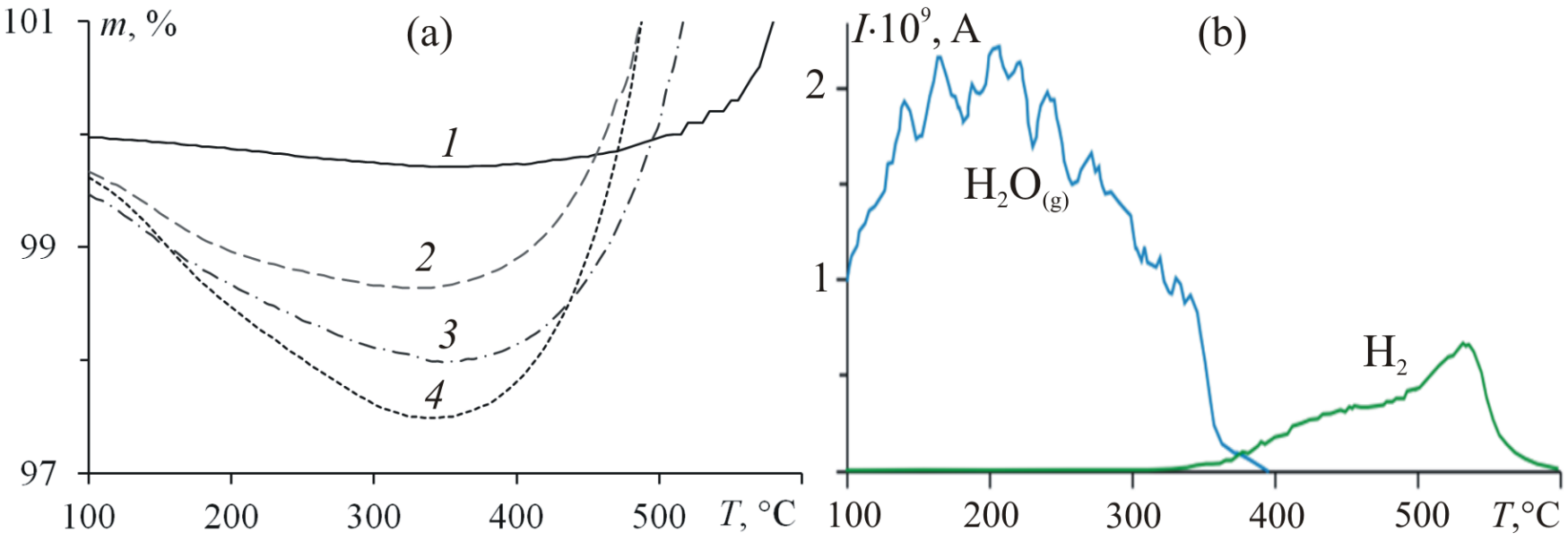

Figure 2. (a) Thermogravimetry curves and **(b)** ionic currents of the gas products for linear heating of Al powders: **a)** ASD-6 (*1*); micron fraction particles of "Alex" (*2*); non-fractioned "Alex" (*3*); submicron fraction particles of "Alex" (*4*)

The gas formation at the metal core/(hydr)oxide shell under isothermal heating of Al particles

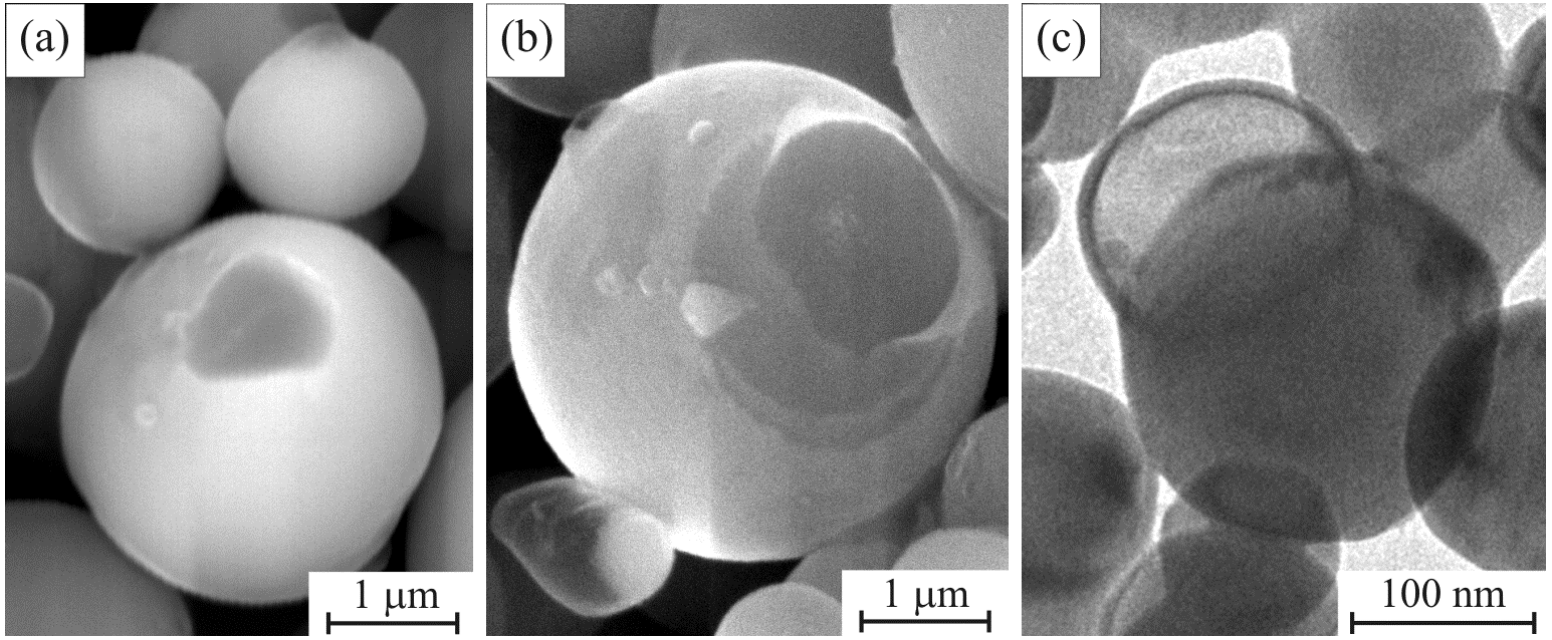

Figure 3. (a, b) SEM and **(c)** TEM images of Al particles heated in air at temperatures (1 h): **a)** 500 °C (ASD-6); **b)** 630 °C (ASD-6); **c)** 450 °C ("Alex")

The gas formation during heating of Al powders occurring at the metal/shell interface (water vapor, hydrogen) causes a decrease in adhesion between the oxide layer and the metal core. As a result, bubbles form on the surface of Al particles due to local peeling of the oxide shell from the metal surface (Fig. 3). The blistering effect was confirmed for both submicron and micron Al particles.