Electronic Supplementary Material (ESI) for Nanoscale Advances.

Supporting Information

The hematite samples were collected from the slags of the steel industry of Kazakhstan. During the production of steel they were obtained as secondary from thick layers of scales which are formed on the surface of the steel strip during hot rolling. In brief, the iron oxides from the steel are dissolved in acid to form ferric chloride, $FeCl_2$. Then the spent pickling solution is fed in droplets through nozzles into a furnace with a temperature of 600 ^{o}C. In a furnace, spray pyrolysis takes place, in which iron chloride decomposes into a dispersed oxide and hydrochloric acid vapor following the pyrolysis reactions:

$$12FeCl_2 + 3O_2 \rightarrow 8FeCl_3 + 2Fe_2O_3\downarrow \quad (1)$$

$$2FeCl_3 + 3H_2O \rightarrow 6HCl\uparrow + Fe_2O_3\downarrow \quad (2)$$

Hydrochloric acid vapors were extracted from the top of the furnace and used for re-etching. The water remaining inside the cores causes swelling which changes the diameter of the solidified surface significantly. Eventually, the particle ends as hollow sphere of iron oxide settle on the bottom of the furnace.