Abstract submitted to 10th SolarPACES International Symposium on Solar Thermal Concentrating Technologies

Solar Production of Zinc from Zinc ore

A. Weidenkaff, F. Sibieude[1], and A. Reller

Inst. Solid State Chemistry, University of Augsburg, Universitätsstr. 1, D-86159 Augsburg, Germany, Tel: (49) 598 3001, Fax: (49) 598 3002, e-mail: anke.weidenkaff@physik.uni-augsburg.de

CNRS-IMP, Bp-5 Odeillo, F-66125 Font-Romeu Cedex, France

Zinc is the fourth most widely used metal, following iron, aluminium, and copper. Zinc concentration is usually performed at the mine site, prior to reaching the zinc processing plant. The most important zinc-ores used in extractive metallurgical industries are zinc carbonate ($ZnCO_3$), zinc sulphide (ZnS) and zinc silicates (Zn_2SiO_4 and $Zn_2SiO_4*H_2O$).

The production of zinc by carbothermal or electrochemical reduction of the corresponding ores requires much energy and leads to immense emissions of carbon oxides. By supplying the high temperature process heat with concentrated solar radiation instead of burning fossil fuels, waste gas emissions can be reduced drastically. In solar thermal processes at temperatures T > 1500 °C, zinc can be produced directly from the zinc ore without any reducing agent.

Zinc produced on this way can be used as solar energy carrier. It can be stored and transported as a solid fuel until it is used by a consumer to produce electricity via zinc air batteries or fuel cells or when it is reacted with water to give hydrogen. The product of these processes is zinc oxide which can be recycled.

The solar experiments were conducted in a 2 kW solar furnace located in Odeillo, France. The basic experimental set-up used for this study consists of a vertical axis solar concentrating system with a sun tracking heliostat and a parabolic mirror to give a energy density of 1600 W/cm^2. The solar chemical reactor consists of a water-cooled sample holder enclosed by a Pyrex-dome positioned at the focus of the solar furnace (see Fig.).

Fig.: Photo of experimental set-up

With this arrangement Willemite (Zn_2SiO_4) is heated by the high-flux solar radiation to temperatures above 1700°C until it is thermally decomposed into zinc and silicate

$$Zn_2SiO_4 \rightarrow 2\ Zn(g) + SiO_2\ (l) + O_2$$

Zinc silicate can be seen as a mixture of zinc oxide and silicium dioxide (2 ZnO* SiO_2). The decomposition process can be divided into two steps:

1st step : $Zn_2SiO_4 \rightarrow 2\ ZnO + SiO_2$

2nd step : $ZnO \rightarrow Zn + 0.5\ O_2$

Thermoanalytic studies reveal that the rate of the decomposition reaction the same as the dissociation of pure ZnO. The liberation of ZnO from the silicate seams not to be the rate limiting step.