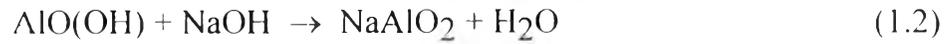
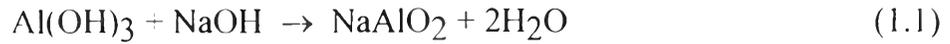


## CHAPTER I

### INTRODUCTION

Aluminum, symbol Al, atomic number 13, atomic weight 26.98154, in group III of the periodic system, is the commonest metallic element in the earth's crust and occurs in rocks, such as feldspars and micas [*Kirk-Othmer (1979); Cotton and Wilkison, (1987)*]. More accessible deposits are hydrous oxides, such as bauxite ( $\text{Al}_2\text{O}_3 \cdot n\text{H}_2\text{O}$ ) and cryolite ( $\text{Na}_3\text{AlF}_6$ ). Aluminum is a hard, strong, white metal. It is prepared on a vast scale from bauxite, weathered rock that consists mainly of aluminum hydroxide minerals. The modern industrial electrolytic method of production was discovered simultaneously and independently by Charles Martin Hall in United States and Paul-Louis Heroult of France in 1886. The technology for extracting aluminum from its ores was further improved in 1888, when Karl Josef Bayer patented in Germany a method for making pure alumina from bauxite.

Bayer Process is the most economical process that takes advantage of the reaction of aluminum trioxide and aluminum hydroxide with aqueous caustic soda to form sodium aluminate as in reaction 1.1 and 1.2. Increasing caustic soda concentration and temperature can move the reaction equilibria to right hand side.



In this process, bauxite is crushed and ground, then digested at 140-230° C and pressure in a strong solution of caustic soda (80-110 g/l Na<sub>2</sub>O). Monohydrate type bauxites, AlO(OH), requires higher temperatures (up to 300° C), higher pressures (as high as 150 atm), and higher caustic concentrations (up to 220 g/l NaO<sub>2</sub>). The residue, known as red mud, contains the insoluble impurities and the sodium aluminum silicate compound, separated from the solution by countercurrent decantation and filtration. After cooling, the solution is supersaturated with respect to alumina. Wash water and spent liquor, after concentration by evaporation, are recycled to the digestion system. For metal production, the products is calcined at temperatures up to 1300°C to produce alumina containing about 0.3-0.8% soda, less than 0.1% iron oxide plus silica, and trace amounts of other oxides [Cotton and Wilkinson (1987)].

There are several hydrated forms of alumina of stoichiometries from AlO.OH to Al(OH)<sub>3</sub>. Addition of ammonia to a boiling solution of an aluminum salt produces a form of AlO.OH which occurs in nature as the mineral *boehmite* [γ-Al<sub>2</sub>O<sub>3</sub>] which is obtained by dehydration of hydrous oxide at low temperatures (~450°C) readily absorbs water and dissolves in acids. A second form of AlO.OH occurs in nature as the mineral *diaspore* [α-Al<sub>2</sub>O<sub>3</sub>] that stable at high temperatures and also indefinitely metastable at low temperatures. It occurs in nature as the mineral corundum and may be prepared by heating γ-Al<sub>2</sub>O<sub>3</sub> or any hydrous oxide above 1000°C.

Sol-gel method is a chemical synthesis technique for preparing gels, glasses, and ceramic powders. It is quite general, in that a variety of organometallic materials can be hydrolyzed, photolyzed, or thermolyzed to give reinforcing, ceramic-type particles. For example titanates can be hydrolyzed to titania, aluminates hydrolyzed to alumina, and metal carbonyls photolyzed or thermolyzed to metals or metal oxides. The synthesis of material by sol-gel process generally involves the use of metal alkoxides, which undergo hydrolysis and condensation polymerization reactions to give gels. One property of the sol-gel process is the ability to control the process all the way, from the molecular precursor to the product. Sol-gel chemistry offers many advantages: a lower processing temperature allows the synthesis of metastable oxide phases and opens a field of opportunities for the synthesis of new materials including both organic and inorganic components [*Schmidt, (1988); James E. Mark, (1992)*].