The discovery of carbon nanotubes (C-NTs) [1] has initiated an exciting, intellectually challenging, and rapidly expanding research field for low-dimensional nanostructures [1–9]. Over the past decade, several other novel 1-D nanostructures such as non-carbon nanotubes [2], nanowires [3], nanorods [4], nanocables [7] and nanobelts [8] have also been discovered. With reduced dimensionalities, this kind of 1-D nanostructures have been regarded as the smallest dimension structures for the efficient transport of electrons, and thus would be expected to be critical to the function and integration of nanoscale devices; meanwhile, some of them have been found to show enhanced photochemical and photophysical properties different from that of bulky or nanoparticle materials [9, 10], based on which many potential applications may been explored, and downscaling materials into 1D nanostructures have become one of the most important strategies to bring novel properties to materials.

1D nanostructures of oxides are especially appealing to chemistry and materials scientists, since oxides are the commonest-seen minerals in the earth, and have now been widely used in various areas, from ceramics, catalysis, sensor, to electronics, optics and magnetics. Intense studies have been carried out on the synthesis of oxides of nanowires as well as the exploration of their novel properties, for example, ZnO nanowires have been successfully prepared through VLS growth mechanism, and well-aligned ZnO nanowire arrays may function as room-temperature ultraviolet nanolasers [10]; SnO₂ nanobelts have been obtained based on simple evaporation method, and single SnO₂ nanobelt have been utilized as room temperature nanosensor for NO₂ [9]. However, despite the several successful cases in the synthesis of oxides 1D nanostructures, such as VLS growth mechanism, template-confined growth, etc, there still lack of a general synthetic strategy, particularly a general understanding about their formation mechanism, which may be the key to the shape control synthesis of high quality oxides or even non-oxides nanowires materials. A comparison between cases from totally different reaction systems may be helpful for us to
understand the anisotropic growth behaviors of 1-D nanostructures in that they may provide similar phenomena, and oxides nanowires may serve as perfect models for their numerous materials and synthetic ways.

Oxides are usually obtained through CVD, Sol-gel, pyrolysis, solution-based redox reaction etc, and some of them have been adjusted to prepare oxides of nanowires. Transitional metal oxides sol can be injected into the pores of templates (carbon nanotubes, AAO or zeolite, etc) to prepare polycrystalline nanowires with the action of capillary force or electronic field. CVD can be adjusted to get single crystal nanowires by properly selecting catalysts to form alloy droplets following a VLS growth mechanism. Also, based on the anisotropic growth nature, oxides of nanowires can be obtained through solution-based redox reactions.

There are different ways to classify the above synthetic routes, for example, reverse micelles method can be regarded as a solution-based route, and meanwhile, the reverse micelles may be considered as a kind of soft template, too. As far as one-dimensional nanostructures are concerned, the key should be focused on the way how atoms or other building blocks are rationally assembled into structure with nanometer size but much larger length, so our attention have been paid on the original driving force for the anisotropic growth phenomena, and reverse micelles have been classified as a kind of template method.

In this part, the preparation of oxides nanowires will be discussed in three independent parts: VLS growth mechanism, template-confined method and solution-based template-free synthetic routes.

1. Oxides of Nanowires Based on Vapor-Transport Method

CVD and PVD have been adjusted to prepare oxides of nanowires, and most of them follow a VLS growth mechanism.

Based on the phase diagram, one can choose appropriate catalysts for the growth of target products. In the oxides-related growth process, metal powders or the corresponding oxides have been used as the starting materials, and the oxygen are usually provided through wet carrying gas. MgO [15], ZnO [16] and SiO$_2$ [17], etc, have been prepared through the VLS mechanism. By properly patterning the catalysts, arrays of ZnO nanorods [10] have also been prepared. Since the catalyst droplet alloy directs the nanowires’ growth and defines the diameter of crystalline nanowires, the nanowires obtained from the VLS process typically terminates at one end in a solid catalyst nanoparticles with diameter comparable to that of the connected nanowires.

As an analogy to VLS growth, Yu et al. [18] have developed a SLS (solid-liquid-solid) growth mechanism to prepare Si nanowires, in which Si are not from the vapor or liquid phase of Si sources but from the Si substrate. In a similar way, Liu et al. [19] have also reported the synthesis of SiO$_x$ nanowires. Meanwhile, Yu et al. have also reported the synthesis of GeO$_2$ [20] and Ga$_2$O$_3$ [21] following VS growth mechanism.

As another enrichment to VLS, Wang et al. [22] have found that, in the growth of SiO$_2$ nanowires by employing Ga as the catalysts, an alloy droplet of Ga-Si may simultaneously serve as catalysts for hundreds of SiO$_2$ nanowires and the diameter of