Biogenic Sulfide Production and Selective Metal Precipitation at low pH for Semiconductor Wastewater Treatment

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Metals are elements which can be found naturally in the form of complex compounds like rock and minerals. The release of metals by natural processes is occurring spontaneously hence the amount released depended on various factors. As a consequence, metal contamination is a wide spread issue around the world, especially in areas where anthropogenic sources like metal related industries are located. For example; electroplating, semiconductor and electronics industries are well known as a source of high loads of metal pollutants which present in their wastewater. The wastewater is usually low in pH and contaminated with many metals. Nickel and zinc are the common metals while in certain cases rare metals such as germanium, gallium and gadolinium can be found depending on the process. The demand of metal is growing every year which results in a rapid increase in the production lines within recent years. Therefore, a proper wastewater treatment on each industrial process is required before release of the effluent to the environment.

Precipitation of metals from wastewater allows metal recovery. The conventional processes are hydroxide and sulfide precipitation. The sulfide precipitation is more stable and effective in a wider range of pH than hydroxide precipitation in terms of resolubility. However, chemical precipitation consumes high amounts of chemicals. Therefore, the biological process is introduced into this area. The sulfate reducing bacteria (SRB) are the group of bacteria which can generate hydrogen sulfide under anaerobic conditions. With their capabilities of sulfide generation, they play a major role in many investigation including metal sulfide precipitation. The treatment can operate continuously if the growth conditions of the SRB are optimal, including nutrition source, electron donor and suitable growth environment like temperature and pH. The optimum growth of SRB is found to be around pH 5-7 (Costa, 2007); however, Bijmans *et al.* (2010) reported that certain SRB species can be operated at pH 4.

Nowadays, there is a separate process which uses generated hydrogen sulfide gas from a SRB reactor to react with certain dissolved metals and forming the insoluble precipitate in another treatment plant. However, the combination of those two treatment plants into one plant is a challenge. Villa-Gomez *et al.* (2011) showed that the inversed fluidized bed reactor has high potential in these aspects. As a consequence, the combination of sulfide metal precipitation and sulfate reduction at low pH along with metal transportation, are this research main goal.

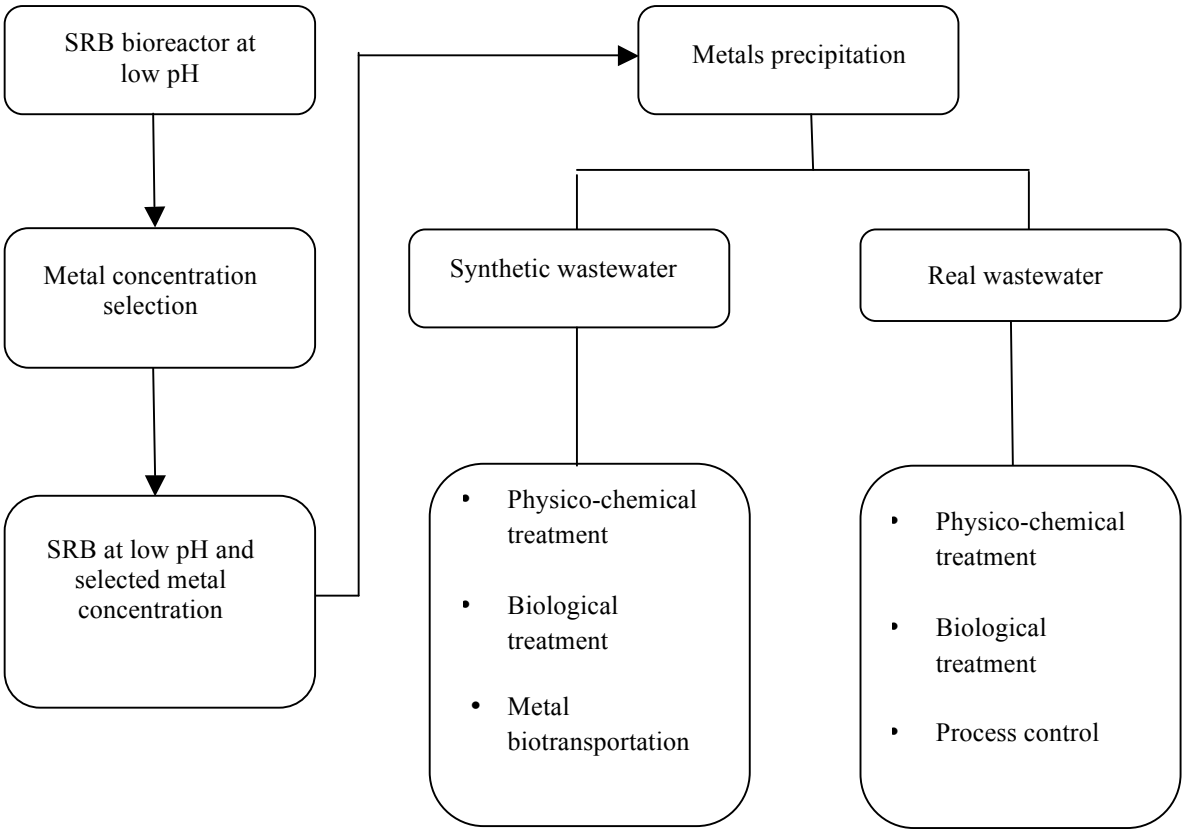

Figure 1.1 Research flow diagram

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