

Chapter 5

5.1 Particle size distribution

It has been shown (Pistoia et al, 1992, Tarascon et al, 1993) that smaller particle size of a cathode material sample gives a better battery performance because it facilitates the rapid diffusion of Li-ion. In this study, the particle size distribution of the five different compounds were performed in order to know whether the sol gel method used can produce the necessary size particularly for battery applications. The particle size distribution is also carried out to find if the material produced can be ground to obtain the necessary size for battery application. The particle size distribution on average spreads between $0.04\mu\text{m}$ to $40\mu\text{m}$. Particle size distribution analysis were done after grinding the samples first since the sample clustered together during preparation.

This type of small particle size distribution of the cathodic material is helpful to improve the battery performance (Pistoia et al, 1992). Good performance in the cells is expected from this compound because the large pores ($4\mu\text{m}$ and above) provide channels for gas transportation and small pores ($\sim 0.3\mu\text{m}$) provide good wetting for the cathode, enhancing the chemical reaction at the interface (Amin, 2000). All the materials were calcined at 800°C for 8 hours in a furnace. After that it was cooled down to room temperature before grinding.

The particle size distribution for sample A to E is as shown in figures 26 to 30. The method used is able to produce submicron size particle with some grinding. Table 8

shows the average diameter for the samples which particle size distribution analysis was done to the materials.

Table 8. Average diameter for the samples

Sample	Mean, μm	S.D., μm
Sample A	5.658	6.20
Sample B	6.508	5.00
Sample C	6.891	9.40
Sample D	5.139	5.01
Sample E	6.442	7.35

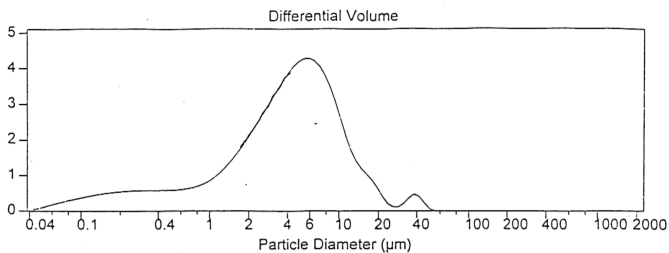


Figure 26. Particle size distribution of Sample A

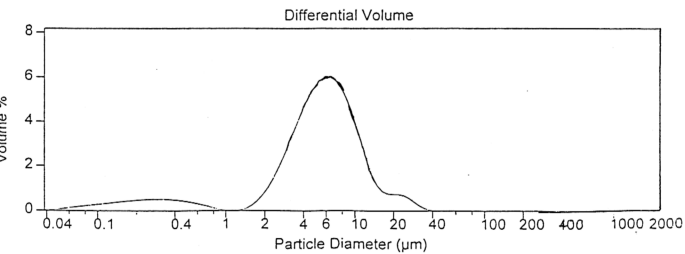


Figure 27. Particle size distribution of Sample B

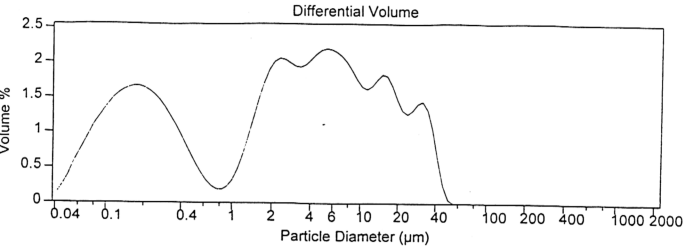


Figure 28. Particle size distribution of Sample C

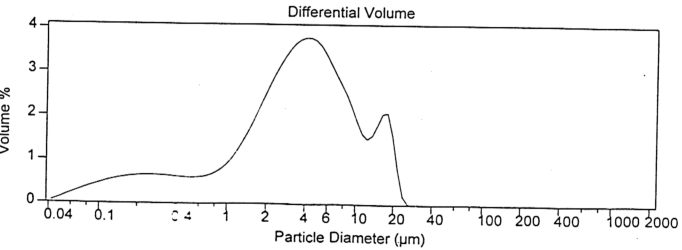


Figure 29. Particle size distribution of Sample D

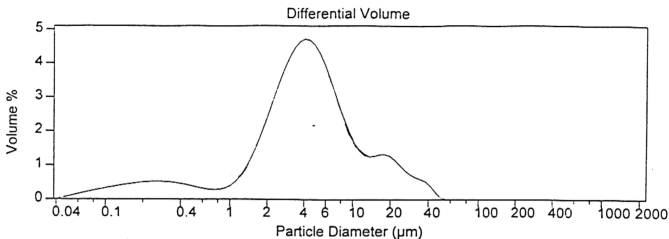


Figure 30. Particle size distribution of Sample E

5.2 Scanning electron microscopy (SEM)

In general, scanning electron microscopy (SEM) analysis reveals the nature of the shape, size and surface morphology of the grains with respect to the method and/or conditions of the synthesis. The cycling performance of lithium-alloy anodes in rechargeable organic electrolyte lithium batteries is highly dependent on the morphology of the metallic matrix. In micro- and submicro- structured matrix alloys the volume expansion due to the insertion of lithium cause much less cracking (Yang et al, 1996). This fact can be used for cathode materials also because it is also an involving intercalation during a charge and discharge process. SEM images can show layered structure (Kang et al, 1999). These are the reasons we did SEM test to our materials.

The SEM analysis were done for five different cathode materials with two different magnifications that is 1500x and 5000x. The SEM photographs are shown in figure 31 to 40. It was found that the grain size for the materials which has been synthesized via the sol gel method is small about 6 μ m. Particle size distribution analysis supports the results shown in SEM.

Cathode materials prepared have almost the same physical nature, with a small variation. It was also observed that the scanning electron micrographs reveal the formation of grains near the micro size. As mentioned above we have done two different magnifications. At 5000x magnification we can see the shape of the grains clearly. The particle shape shows roundness. The cathode materials having such surface morphology and grain sizes can be used as an active cathode material having applications for high performance in Li-ion rechargeable batteries (Prabaharan et al, 1997).

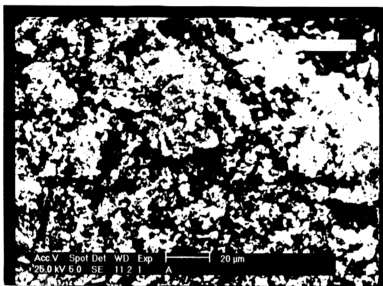


Figure 31. SEM micrograph of Sample A at 1500x magnification

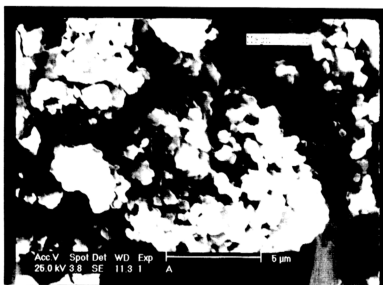


Figure 32. SEM micrograph of Sample A at 5000x magnification

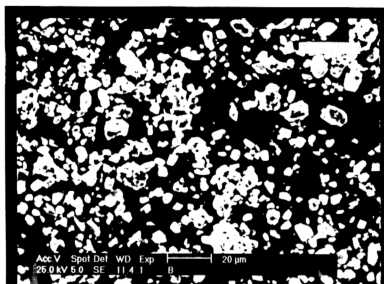


Figure 33. SEM micrograph of Sample B at 1500x magnification

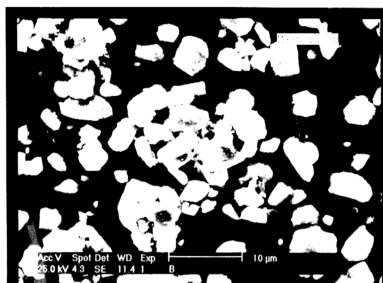


Figure 34. SEM micrograph of Sample B at 5000x magnification

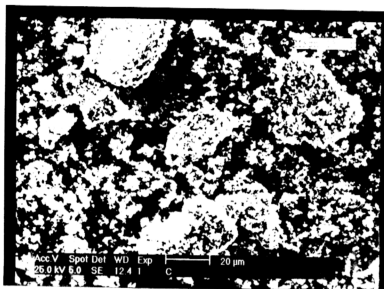


Figure 35. SEM micrograph of Sample C at 1500x magnification

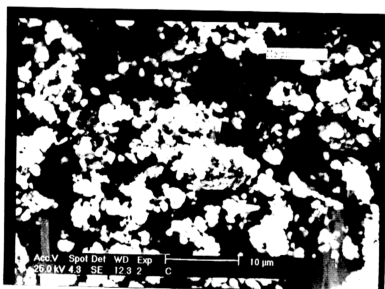


Figure 36. SEM micrograph of Sample C at 5000x magnification

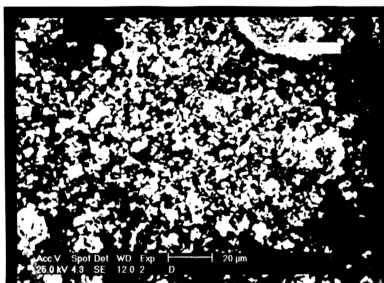


Figure 37. SEM micrograph of Sample D at 1500x magnification

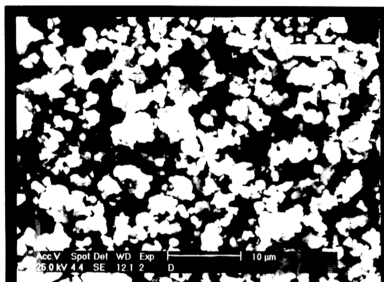


Figure 38. SEM micrograph of Sample D at 5000x magnification

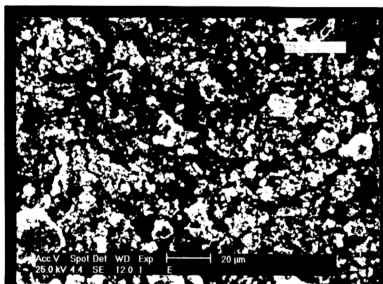


Figure 39. SEM micrograph of Sample E at 1500x magnification

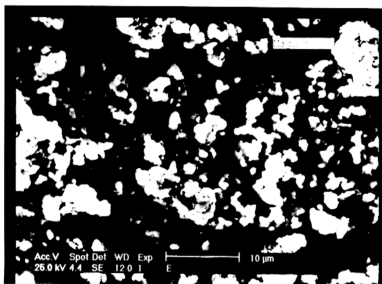


Figure 40. SEM micrograph of Sample E at 5000x magnification