The main differences between the lithium-ion and the lithium-polymer batteries can be described as follows. Lithium ion batteries have a fluid organic electrolyte while the negative electrode is made from a lithium/carbon intercalation electrode. The electrolyte has a high conductivity. The non-metal electrode increases the safety in comparison with a Li-metal electrode. What is sold today as lithium-polymer batteries is in fact a combination of a polymer electrolyte and a lithium/carbon intercalation electrode. The use of the polymer simplifies the manufacturing. Strictly speaking the so-called lithium-polymer batteries are polymer lithium-ion batteries.

The lithium-polymer cell is just entering the market. In the long run, it is expected that lithium-polymer batteries can be manufactured at lower costs than lithium-ion batteries. Further, they allow very flexible battery designs. This makes lithium-polymer batteries an interesting solution for chip integration or smart cards, but also larger capacities for power applications are available for field demonstrations now.

Compared to NiCd or nickel-metal hydride batteries, a disadvantage of lithium batteries is that they are less tolerant to operations with high currents, which makes discharge at high currents noticeably more difficult. Also, they currently do not achieve the same cycle life as NiCd or nickel-metal hydride batteries. However, both points are subject to R&D and especially concerning the power rating, significant steps forward have been achieved.

Lithium batteries require constant current/constant voltage charging (Figure 18.23a). The recharge behaviour is very good. Full charging of the battery is not as important as with lead acid batteries to achieve adequate lifetimes. However, the voltage limit must be observed very accurately. The end-of-charge voltage is limited to 4.1 V and must not be extravagated by more than 50 mV. High voltage causes the formation of metallic lithium. In series-connected cells, it must be assured that the voltage limits are kept within the acceptable limits for each individual cell.

The discharge of lithium batteries must be restricted to the material-specific end-of-discharge voltage. Again, over-discharge leads to the formation of metallic lithium. For the cobalt type, the end-of-discharge voltage is 2.3 V/cell and for the manganese type 2.7 V/cell. Figure 18.8 shows the discharge curves of a lithium-ion battery at different discharge currents. The battery capacity only slightly depends on the discharge current. In addition, Figure 18.9 shows the temperature dependence of the discharge curves. As the ion migration depends strongly on the temperature, the low-temperature performance is not too good.

18.4.6 Double-layer Capacitors

Conventional capacitors have a dielectric between the electrodes. Their capacity is determined by the dielectric number and the area of the electrodes. The so-called double-layer capacitors have an ion-conducting electrolyte between the electrodes. Therefore, an agglomeration of charge carriers at the interface between the electron-conducting and the ion-conducting interface is possible. The interface is called the electrochemical double layer. In contrast to secondary batteries, no chemical reaction and no charge transfer from the electrode to the electrolyte happened. Therefore, no changes in the material structure occur resulting in cycle lifetimes of several hundred thousands. The storing of energy