the positive electrode. Some of the gas can be absorbed by the metal of the negative electrode, but the rest remains as gas in the cell. If the discharge is continued, oxygen is formed at the negative electrode, which further increases the gas pressure and leads to oxidation of the metal electrode. When the overpressure is large enough, the safety vent opens and the gas pressure falls again. To avoid this, appropriate measures must be taken especially if long series-connected strings are used. References [12, 13], and Chapter 19 of this book discuss a number of possible solutions for this problem.

Nickel-metal hydride batteries have replaced NiCd batteries in the market for portable appliances (e.g. mobile phones, camcorders and power tools) to a large extent due to their better environmental compatibility and their higher gravimetric energy density (Figure 18.7). However, NiMeH batteries are not commercially available in larger capacities as necessary for autonomous power supply systems. The reasons for this are mainly the costs that are actually approximately five times higher than the lead-acid batteries. Currently, there is no evidence that NiMeH batteries will play a major role in storage for autonomous power supply systems except for small technical appliances with some 10 Wp. It is more likely that Lithium batteries may enter this market, but NiMeH batteries are seen as an interim technology between NiCd and Lithium batteries.

18.4.4 Rechargeable Alkali Mangan (RAM) Batteries

Alkali-mangan cells are well known as primary batteries for several decades. Over the past few years this technology has entered the market as a secondary battery. In the beginning, the primary batteries were used and recharged. Meanwhile, rechargeable alkali-manganese (RAM) cells are in the market specially designed as a secondary battery. RAM batteries are gas tight. The nominal voltage is 1.5 V/cell and is therefore 25% higher than that of NiCd or NiMeH batteries. Currently, only small batteries with capacities of up to 5 Ah are in the market. They are significantly less expensive than the NiCd batteries. RAM cells have higher inner resistance than all other batteries discussed here. RAM cells are much more environmentally compatible than NiCd batteries as they contain no heavy metals.

The major drawback is the low deep-cycling lifetime of the RAM cells. Up to now only approximately 20 to 50 full cycles (100% DOD) are available. However, if only very shallow cycles are required (1–5% DOD), several thousands of cycles can be achieved. Even though RAM cells are currently not suited to larger autonomous power supply systems, they are interesting storage systems for small appliances with limited lifetime or usually very shallow cycling like, for example, some kinds of toys. Emergency lighting systems may be another field of application where normally only the surveillance electronics need any power (recharged by a small PV generator) and only in case of an emergency the full capacity is needed.

18.4.5 Lithium-ion and Lithium-polymer Batteries

Lithium batteries have been the most emerging battery technology over the last few years. Primary lithium batteries were already well known due to their very high energy density and shelf lifetimes of up to 10 years without any major self-discharge. Nowadays, lithium-ion and lithium-polymer batteries have captured the market for portable applications like