

## Other uses of Manganese

Manganese is also used as an alloy with metals such as aluminium and copper. Important nonmetallurgical uses include [battery cathodes](#), soft ferrites used in electronics, micronutrients in [fertilizers](#), micronutrients in animal feed, [water treatment chemicals](#), colorant for automobile undercoating, bricks, frits, glass, textiles, and tiles. The product “manganese violet” is used for the coloration of plastics, powder coatings, artist glazes, and cosmetics.

High purity manganese is primarily used in batteries, series 200 stainless steel, speciality alloys, and fertiliser and trace nutrients. The products primarily utilised for high purity manganese are Electrolytic Manganese Metal (EMM), Electrolytic Manganese Dioxide (EMD) and Manganese Sulphate (MS). The utility of these high purity manganese products is highlighted in the table below.

Product	Key Use
Electrolytic Manganese Metal	Specialty Alloys, Batteries
Electrolytic Manganese Dioxide	Batteries
Manganese Sulphate	Batteries

## Manganese in Battery Cathodes

Manganese is utilised within two of the most prominent batteries in production, being the Nickel Manganese Cobalt (NMC) and Lithium Manganese Oxide (LMO) batteries. Within LMO batteries, there is approximately 61% manganese in the cathode, being the majority mineral present. Whereas the manganese in the cathode of an NMC battery constitutes 20-30% of the total cathode material.

Current battery compositions contain various combinations of cobalt, nickel, manganese and aluminium. These transition metals are suitable due to their various natural ionic states and capacity to hold and discharge electrons. Of these minerals, manganese offers the cheapest solution for producers of battery technology, being more than 43 times cheaper than cobalt. Manganese is the lowest cost mineral to extract, and it has the second highest reported reserves of all minerals commonly utilised within cathodic materials of batteries.

Aluminium is currently the closest cost competitor to manganese. Compared to aluminium, manganese offers a safer solution, with aluminium batteries having a thermal runaway of 195°C. Comparatively, LMO and NMC batteries have a thermal runaway of 240°C and 230°C respectively. Another key differentiator between aluminium and manganese batteries is the number of charges attainable from each battery, otherwise known as cycle durability. Lithium Nickel Cobalt Aluminium Oxide batteries have an average cycle durability of 1000-1,500 charges, while LMO batteries have around 700 charges and NMC batteries have around 5,000 charges. The degradation of battery life in the Nissan Leaf for instance, has been acknowledged in the warranty. The warranty covers the battery capacity loss (decrease in car range) for the first 100,000 miles the car travels.

## A Bullish Outlook for Manganese if the Tech Wins Out

Manganese will be an interesting mineral to watch. With the increasing prominence of battery technology, it can be safely assumed that manganese will play a significant role. Is manganese the

forgotten battery mineral though? It's definitely not forgotten but appears to be overlooked. We wondered why manganese hasn't had the same uplift as other battery commodities. In our opinion the key reason that manganese has not received the same uplift as other commodities in the battery space is due to the mining technique used to extract the ore. Manganese is a bulk commodity which is mined in high volumes. This creates a situation where small demand uplifts have minimal effect on ore. For manganese to receive the same upside as other battery minerals, it is likely to be gained through large demand for specific ores needed to produce high purity manganese products. This could see the price for high purity manganese prices decouple from industrial steel use manganese.