Inexpensive/environmentally friendly nanostructured MnO_2 recovered from Amazon and Italian mining tailings as electrode materials for rechargeable batteries.

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Mining generates humongous amounts of waste materials, often stored in tailings ponds. Issues connected to mining waste accumulation into tailings ponds have been emerging as a serious threat to environmental safety and human health. However, mining waste may represent a valuable source of secondary raw materials to be exploited for the synthesis of value-added nanomaterials. Besides, the "Critical Raw Materials Act", enacted by the European Commission in March 2024, obliges Member States to supply 10% of their internal demand through extraction within the European Union and 25% through recycling. In this regard, the reconversion of mining waste into non-harmful and high value-added materials is considered one of the most promising options.

The present contribution briefly illustrates a few examples of mining tailings (iron, manganese bauxite) and industrial wastes (e.g. fishery and agricultural residues) conversion into advanced functional materials (like construction fillers, fertilizers, and pollutant adsorbents).In particular, the contribution delves into Amazon (Brazilian) rainforest Mn-ore tailings as "low-end "raw materials for manganese oxide-based conversion anodes to be used in rechargeable Li-ion (or Na-ion) batteries. . Specifically, the present work takes advantage of alkaline (e.g. KOH) oxidative fusion to carry out manganese recovery from tailings (as potassium manganate, K_2MnO_4). Efficient manganese separation from other elements, especially iron, was attained by controlling fusion process parameters such as, temperature, duration, and tailings/KOH ratio. Nanostructured battery grade MnO_2s belonging to the non-stoichiometric birnessite (δ-MnO_2) oxide category were synthesized by directly reducing the manganate leachate recovered from Mn-tailings with sundry "green" reducing agents (e.g., H_2O_2, ethanol, etc.). Specific capacities measuring up 400 mAh/g (above standard graphite) were achieved when δ-MnO_2 was employed as conversion anode material in lithium-ion batteries. In light of circular economy principles, such an approach is also amenable to the recovery of manganese from different sources, including Italian decommissioned mines.