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RECYCLE WITH POWER

THE HIGH ENERGY BALL MILL EMAX HELPS TO RECYCLE HAZARDOUS WASTE FROM MINES



Mine wastes, commonly referred to as tailings, is the byproduct generated during the extraction and processing of various kinds of ores. This waste material primarily consists of finely ground rock particles, water, and residual chemicals used in the extraction process. The management and disposal of mine wastes are crucial due to its potential environmental impacts, which include soil and water contamination. If not properly managed, these tailings can lead to significant ecological damage, affecting both terrestrial and aquatic ecosystems.

To mitigate these environmental risks and simultaneously promote the valorisation of secondary mineral resources available in Europe, effective recycling and reuse strategies are essential. In this context, the Horizon Europe START project* ("Sustainable Energy Harvesting Systems Based on Innovative Mine Waste Recycling", <https://www.start-heproject.com/>) is transforming waste secondary sulphide materials in sustainable high added-value components for tellurium-free thermoelectric devices, thus contributing to more sustainable industrial processes. Additionally, innovative approaches to tailings management, such as the development of new technologies for waste treatment and the implementation of

stricter environmental regulations, can further reduce the negative impacts of copper mining on the environment.

The overall concept of the START project of “transforming mining waste into waste heat recovery materials” translates into the production of p-type semiconductor materials that incorporate discarded residual secondary sulphides, mainly tetrahedrite, a widely available copper-antimony sulfosalts mineral that does not contain tellurium. Sites containing these suitable sulphide minerals were identified in various historical European mines, based on the volume of sulphides, the presence and content of tetrahedrite, and accessibility and logistical issues (Figure 1). The production of the mineral-derived tetrahedrite p-type materials is being carried out by powder technology (Figure 2). On a laboratory scale, the powders are produced at LNEG facilities using the High Energy Ball Mill Emax. The unique characteristics of Emax, and in particular the high levels of mechanical energy input, allow the reactivity of the powders to be changed so that the direct synthesis of nanostructured mineral-derived tetrahedrite powders occurs near room temperature (Figure 3).

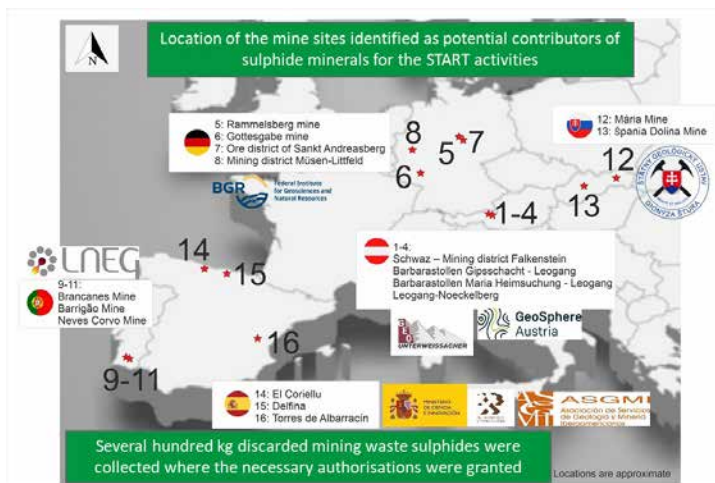


Figure 1: START sampling sites

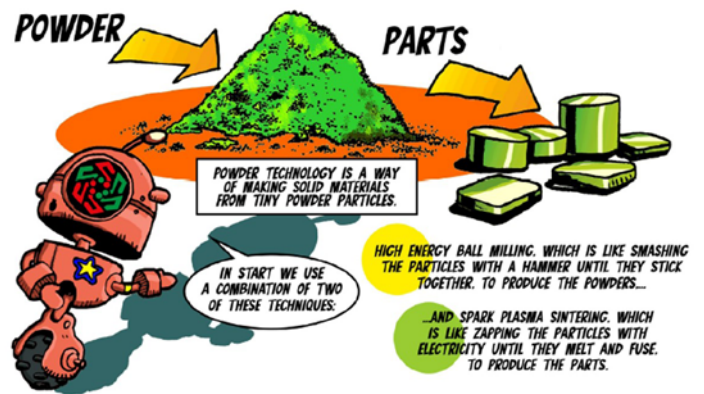


Figure 2: Powder technology in START

The High Energy Ball Mill Emax

The Emax (Figure 4) is an entirely new type of ball mill designed for high-energy milling. Its unique combination of high friction and impact results in extremely fine particles within the shortest amount of time. This innovative ball mill offers faster and finer grinding than any other ball mill available. With a speed of 2000 min⁻¹, it allows for ultra-fast pulverization of samples. Additionally, the Emax features water cooling, which permits continuous operation without the need for cool-down breaks. The temperature-controlled grinding ensures consistent results, and the special jar design improves the mixing of the sample, resulting in a narrow particle size distribution.



Fig. 4: High Energy Ball Mill Emax

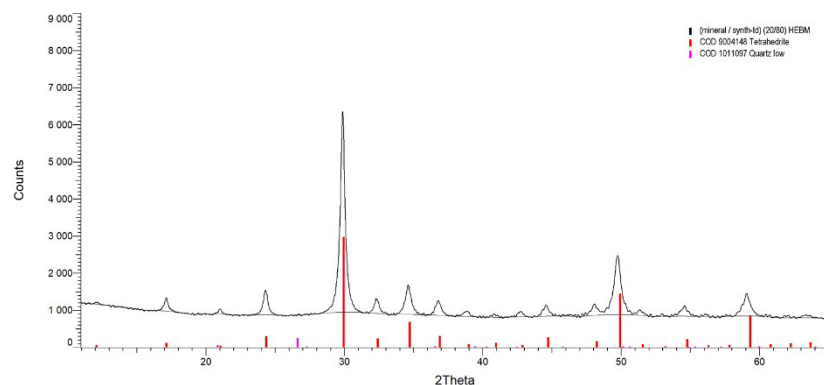


Figure 3: A typical XRD pattern of mineral-derived tetrahedrite powders (p-type) produced by HEBM.

Functional principle: Grind sizes in the submicron range

The High Energy Ball Mill Emax combines high-frequency impact, intensive friction, and controlled circular jar movements to a unique and highly effective size reduction mechanism. The grinding jars have an oval shape and are mounted on two discs respectively which move the jars on a circular course without changing their orientation.

The interplay of jar geometry and movement causes strong friction between the grinding balls, sample material and jar walls as well as a rapid acceleration which lets the balls impact with great force on the sample at the rounded ends of the jars. This significantly improves the mixing of the particles resulting in smaller grind sizes and a narrower particle size distribution than is possible to achieve in ball mills.

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