Mechanochemistry: Sustainable extraction and recovery of metals
- The case of lithium silicate minerals –

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Tobias Necke, Fraunhofer IWKS

Mechanochemical leaching experiments were performed on hard rock lithium ores, composed of silicate minerals such as α-spodumene ($LiAlSi_2O_6$), petalite ($LiAlSi_4O_{10}$) or lepidolite ($K(Li,Al)_3(Si,Al)_4O_{10}(F,OH)_2$). The focus of this study was to determine whether mechanochemistry in combination with NaOH is a suitable method for lithium extraction from these minerals, which are known to be poorly soluble at ambient conditions. Inductively coupled plasma atomic emission spectroscopy (ICP-OES) was used to validate the extraction behavior of the minerals, showing promising extraction rates for spodumene (64 %) and petalite (77 %) and significantly lower values for lepidolite (28 %). To study changes in the solid materials X-ray powder diffractometry (PXRD) and transmission electron microscopy (TEM) were performed to investigate indications for crystallite reduction and amorphization due to high-energy ball milling. By means of PXRD, an unspecified silicate phase was determined several times, which is seen as a reaction product and will be the subject of further investigations. The obtained leaching results correlate well with the accessibility of lithium due to the formation of cleavage planes and bonds to be broken in the crystal lattice in the investigated minerals. The experimental results confirm that mechanochemistry is a potential method for the extraction of lithium. However, for industrial application, the extraction rates need to be increased by adjusting the parameters.