European Training Network for the Remediation and Reprocessing of Sulfidic Mining Waste Sites

Mechanochemical activation of sulfidic mining waste rock for alkali activation

He Niu, Paivo Kinnunen, Mirja Illikainen*
Fibre and Particle Engineering Research Unit, University of Oulu, Finland.

Abstract

Alkali-activation is a promising method to turn mining waste into construction materials. However, the low reactivity of minerals can be a challenge in alkali-activation. In the present study, the reactivity of waste rock was increased by mechanochemical treatment with Li-containing grinding aid. X-Ray diffraction (XRD) and Fourier-transform infrared spectroscopy (FTIR) analysis were utilized to display the structural alternation of individual minerals. A schematic implication was provided according to the results of Transmission electron microscopy (TEM). The alkaline (Al, Si) solubility displayed the enhanced chemical reactivity of waste rock. The results indicated that mining waste rock can be a promising candidate for alkali activation and the possibility of recycling of such considerable amounts of waste.

Ground waste rock

Experimental design:

- ❑ Vibratory disc milling: 8 and 16 min with and without LiCl
- ❑ Analysis with SEM, solubility test, TEM, XRD and FTIR

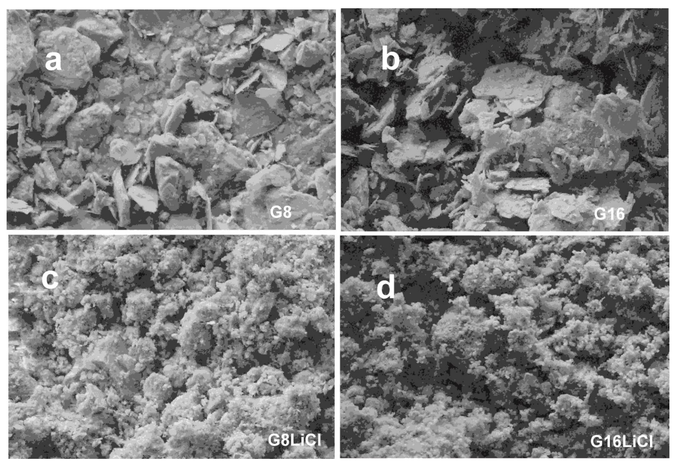


Figure 1. SEM images of ground SUL_NC_01, a) 8-min and b), 16-min grinding without LiCl; c) 8-min and d) 16-min grinding with LiCl

Table 1. Chemical composition of SUL_NC_01(Lost of ignition at 950°C)

Main component	SiO_2	Al_2O_3	CaO	MgO	K_2O	Fe_2O_3	SO_3	TiO_2	MnO	L.O.I.
(wt%)	52.31	12.15	0.56	1.98	1.49	16.69	12.34	0.56	0.13	9.7

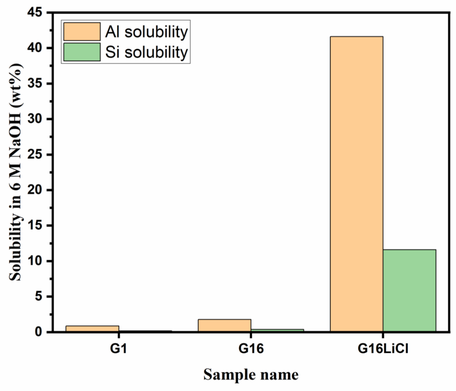


Figure 2. Alkaline solubility of SUL_NC_01

- ❑ LiCl significantly increases Al solubility
- ❑ Changes in Si solubility are not that high due to inert phases such as quartz and Pyrite.

Mechanism of Li^+ effect on mica

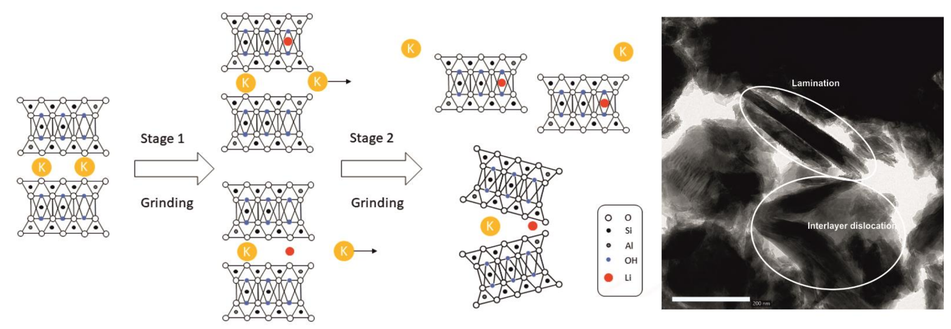


Figure 3. Schematic implication of mica structure change; TEM image

There are possibly two factors which lithium ions can influence the amorphization of waste rocks as follows: 1) Li^+ shows propensity to enter the vacant position in the dioctahedral layer of mica, thereby altering the charging balance and expelling K^+ in the interlayer positions. 2) the Li^+ is the smallest cation size and possesses highest electronegativity within alkali metals; therefore, it is likely to insert in the interlayer and exchanging K^+ outside.

XRD and FTIR analysis

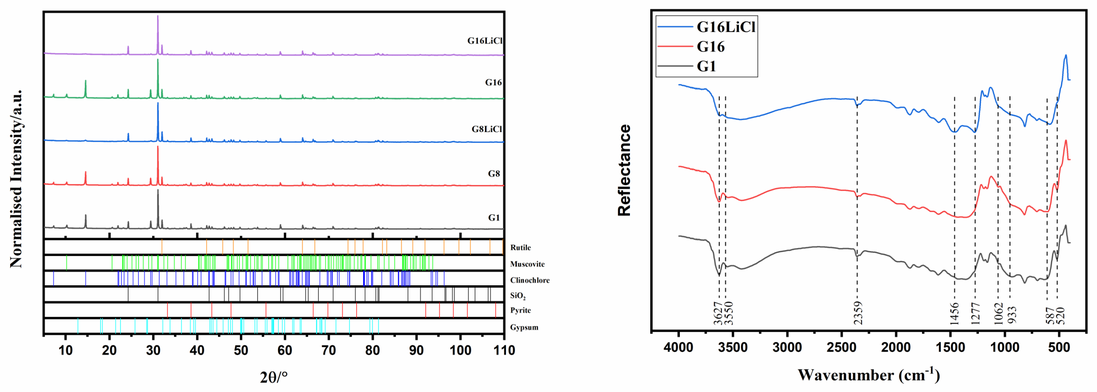


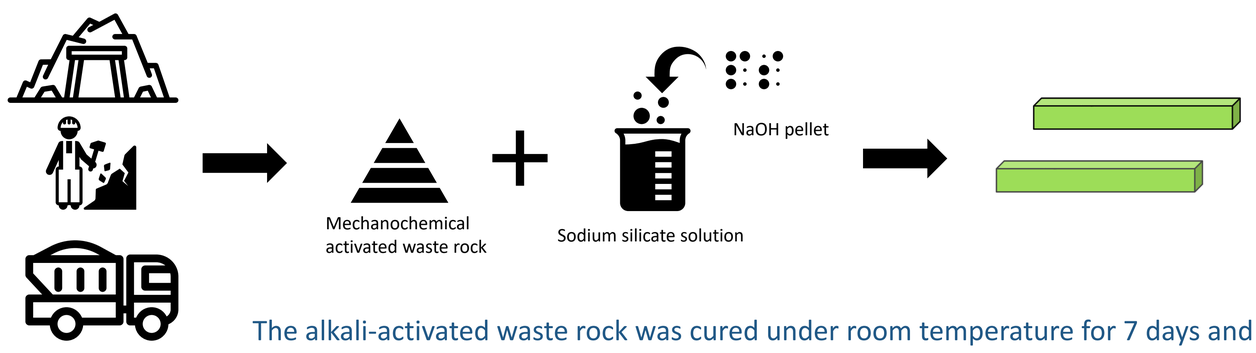
Figure 4. XRD, FTIR patterns of ground SUL_NC_01

After 16-min grinding with LiCl, the sample becomes practically X-ray amorphous and dehydroxylation occurred.

Alkali-activated waste rock

Table 1. Mix design of alkali activated waste rock

Sample name	Waste rock (wt%)	NaOH (wt%)	Sodium silicate solution (wt%)	Water/binder ratio
G16WR	73.2	1.7	25.1	0.2



The alkali-activated waste rock was cured under room temperature for 7 days and 28 days. The compressive strength can reach 6.64 MPa (±0.91) and 10.27 (±0.81) MPa, respectively.

Conclusion

The mechanochemical activation with chemical assist (lithium chloride) can significantly improve the chemical reactivity of the waste rock from copper-zinc mining site. This enhancement reflects from the x-ray amorphous, dehydroxylation and alkaline solubility. A schematic implication of collapsing mechanism of mica minerals were proposed according to the feature of mica mineral and the lithium cations. The inorganic polymer generated by mechanochemical activated waste rock gains promising compressive strength at 7 days.

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