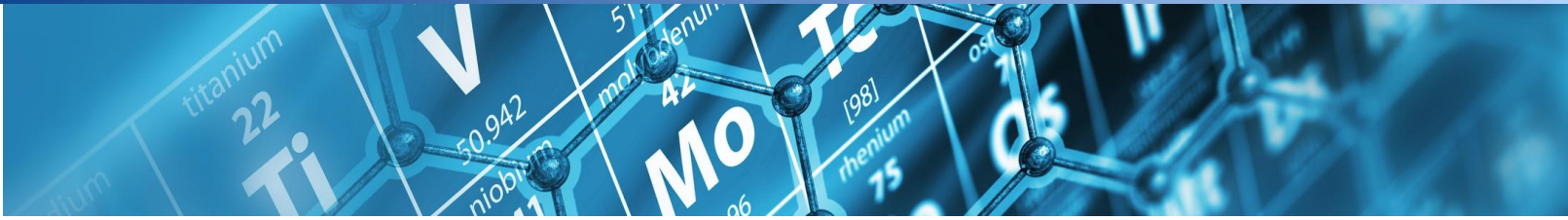


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Pseudo-bulk elemental analysis of pegmatite lithium ores by LA-ICP-MS

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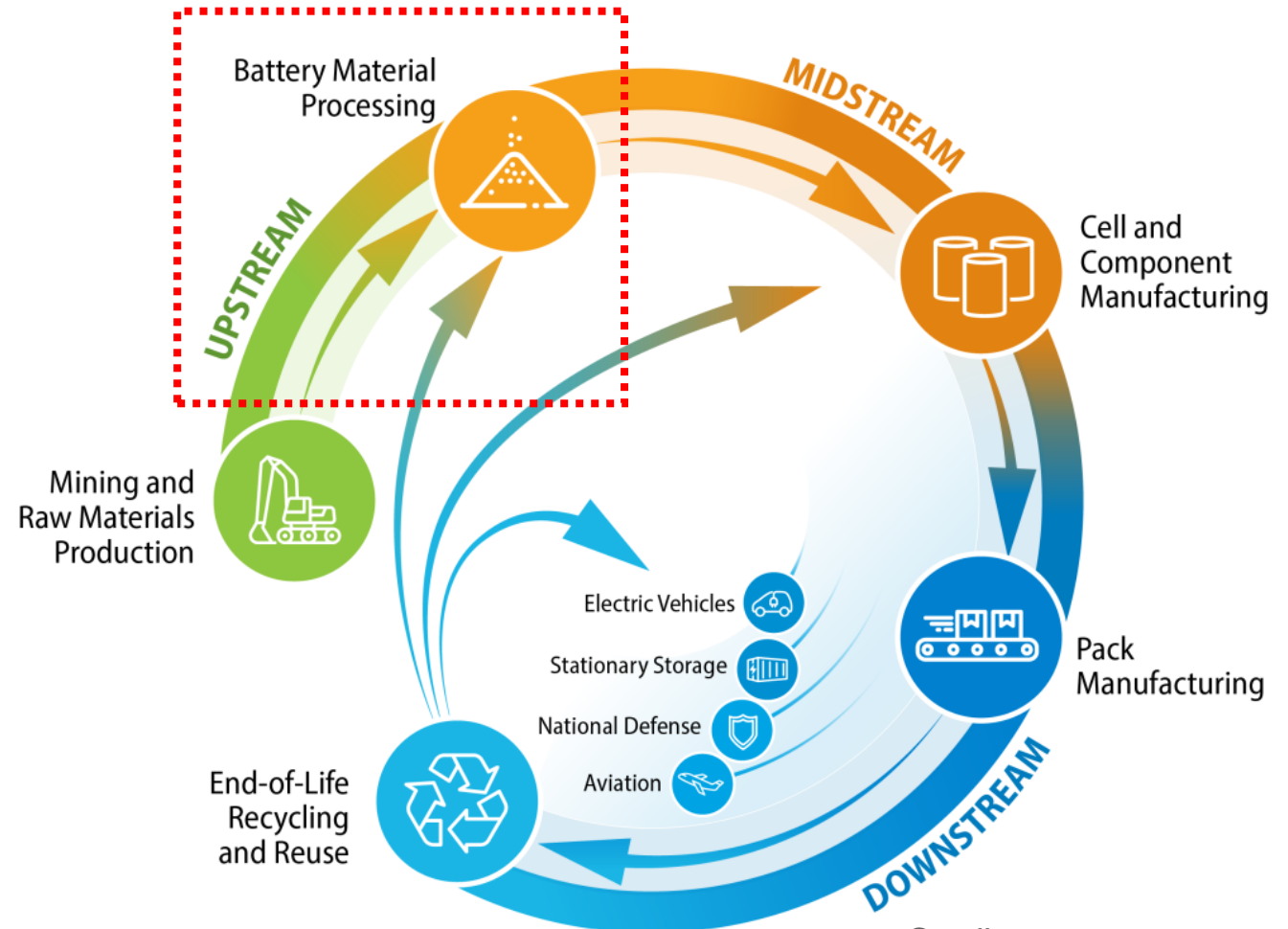


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Lithium ore and the LIB supply chain

- Lithium production derives from two raw material sources: lithium brines and “hard rock” ore containing Li-Al-Si minerals
- The most important lithium bearing minerals in ore are spodumene ($\text{LiAlSi}_2\text{O}_6$) and petalite ($\text{LiAl}(\text{Si}_4\text{O}_{10})$)
- Typical mine ore contains 1%–2% Li_2O equivalent (~20% spodumene) and lithium concentrate contains 6%–7% Li_2O equivalent (~80% spodumene)
- Ores and concentrates are commonly analyzed for elemental composition using XRF, ICP-OES, and ICP-MS

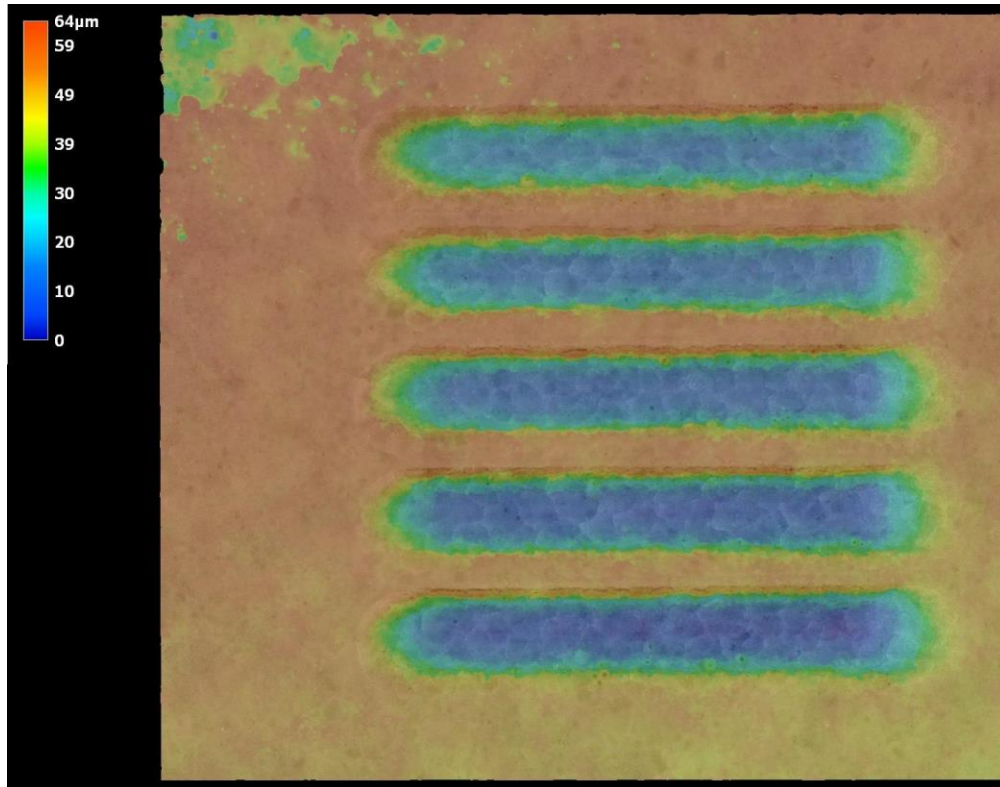


Credit:
US National Renewable Energy Laboratory

- OREAS 750 – 753 and NCS DC 86303 analyzed as quality control reference materials for method validation
- Single-point external calibration using OREAS 999 ore concentrate for sample-standard bracketing
- Internal standardization using ^{29}Si signal and reference values for Si (all OREAS) or SEM-EDS mean Si concentration for NCS DC 86303
- Each OREAS pellet was ablated with five replicate scan lines per day on five different days ($n = 25$) using the same laser parameters
- NCS DC 86303 was analyzed with 10 ablation scan lines on 1 day after OREAS analyses were all complete

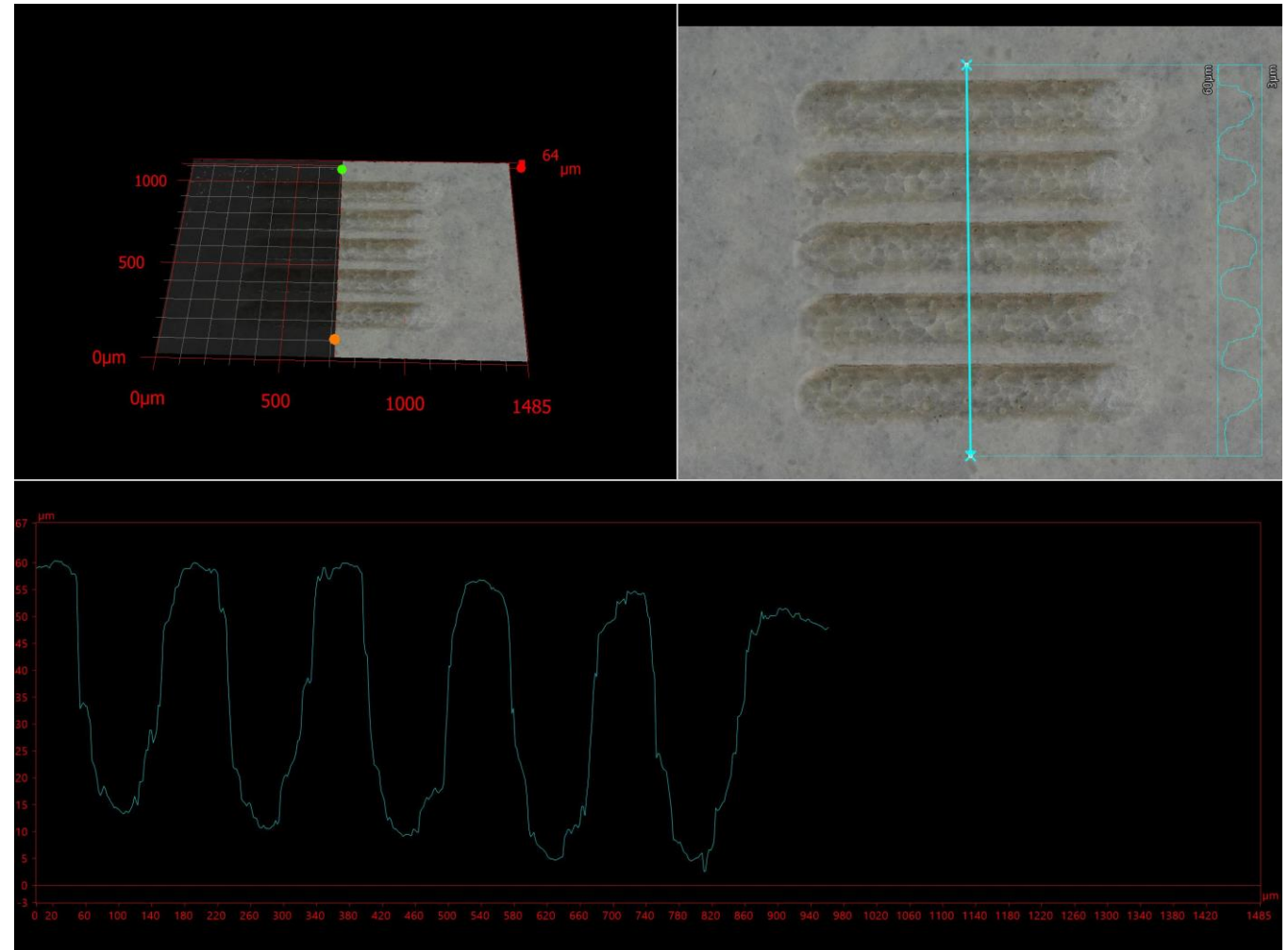


How do the nanopowder pellets ablate?



Above: 3D depth composite heat map of OREAS 999 from Keyence VHX digital optical microscopy

Right: Depth profile of scan line troughs showing 45 - 50 μm deep penetration from surface



- LA-ICP-MS of pelletized powdered lithium pegmatite ore is a promising alternative to bulk digestion and fusion methods that will be faster and more versatile when ready for commercial deployment.
- Precision from replicate ablations on nanopowders and even non-nanopowder pellets is robust with consistently low RSD%. Per scan line measurement uncertainty (2SE) was generally one order of magnitude lower than the concentration from each ablation, suggesting intra-scan line heterogeneity is not an issue.
- Accuracy is excellent for OREAS 750 – 752 nanopowder pellets, while 753 requires further investigation to see if a multi-point calibration will improve accuracy for low Mg and Ca ores.
- NCS DC 86303 requires significant further research to determine if biased high results for Li, Na, and K are due to spatial heterogeneity, contamination, calibration mismatch, or unreliable reference values.