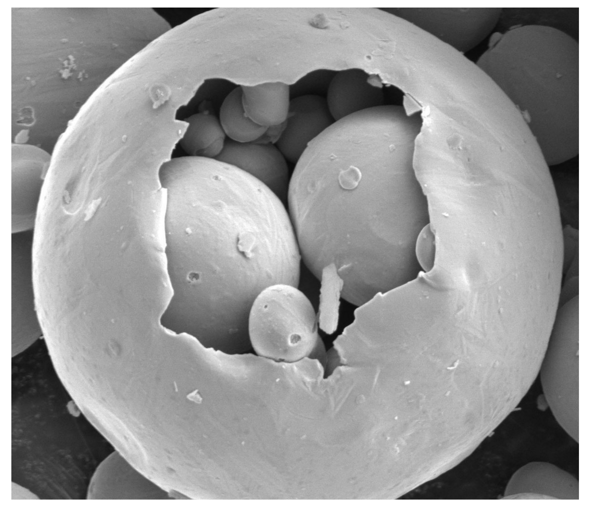

Reconditioning of Titanium Powders for Additive Manufacturing

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Problem Statement

The metal AM (additive manufacturing) sector has an estimated revenue over \$11 billion in 2024. While short turnaround time, high-degree in automation, and flexibility in design prompt the AM industry to grow quickly. One pain point in the industry is early disposal of high-value, specialty alloy powders due to oxidation. Such as those Ti-6Al-4V. After repeated uses/prints, oxygen content builds up in these partially used powders, and going into waste disposal or making low-value demos will be their destiny.

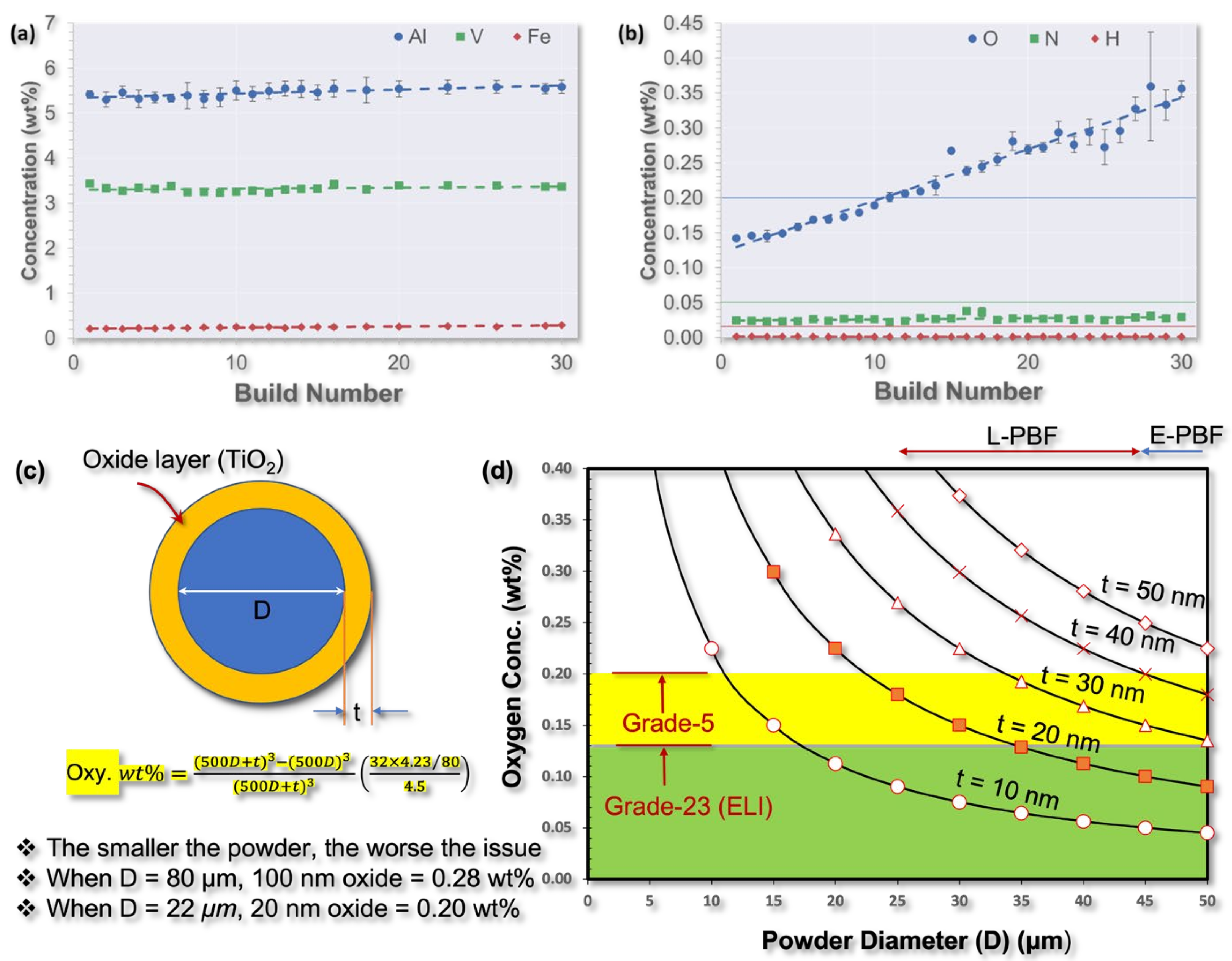

Figure 1. (a-b) Repeated uses/builds raise concentration of oxygen in Ti64 powders. In comparison to rather little variation of metallic and other non-metallic compositions, linear increase of oxygen is evident. Graphs from M. Ramulu, et al., Materialia. (c) Core-shell model for oxide layer influence to oxygen concentration. (d) Influence of oxide layer thickness to powder quality.

Approach

Oxidized Ti64 powder was investigated by Scanning Electron Microscopy (SEM), Energy-dispersive X-ray spectroscopy, and X-ray Photoelectron Spectroscopy (XPS). A gas phase process as well as a separation process were explored to remove oxide layers.

Results

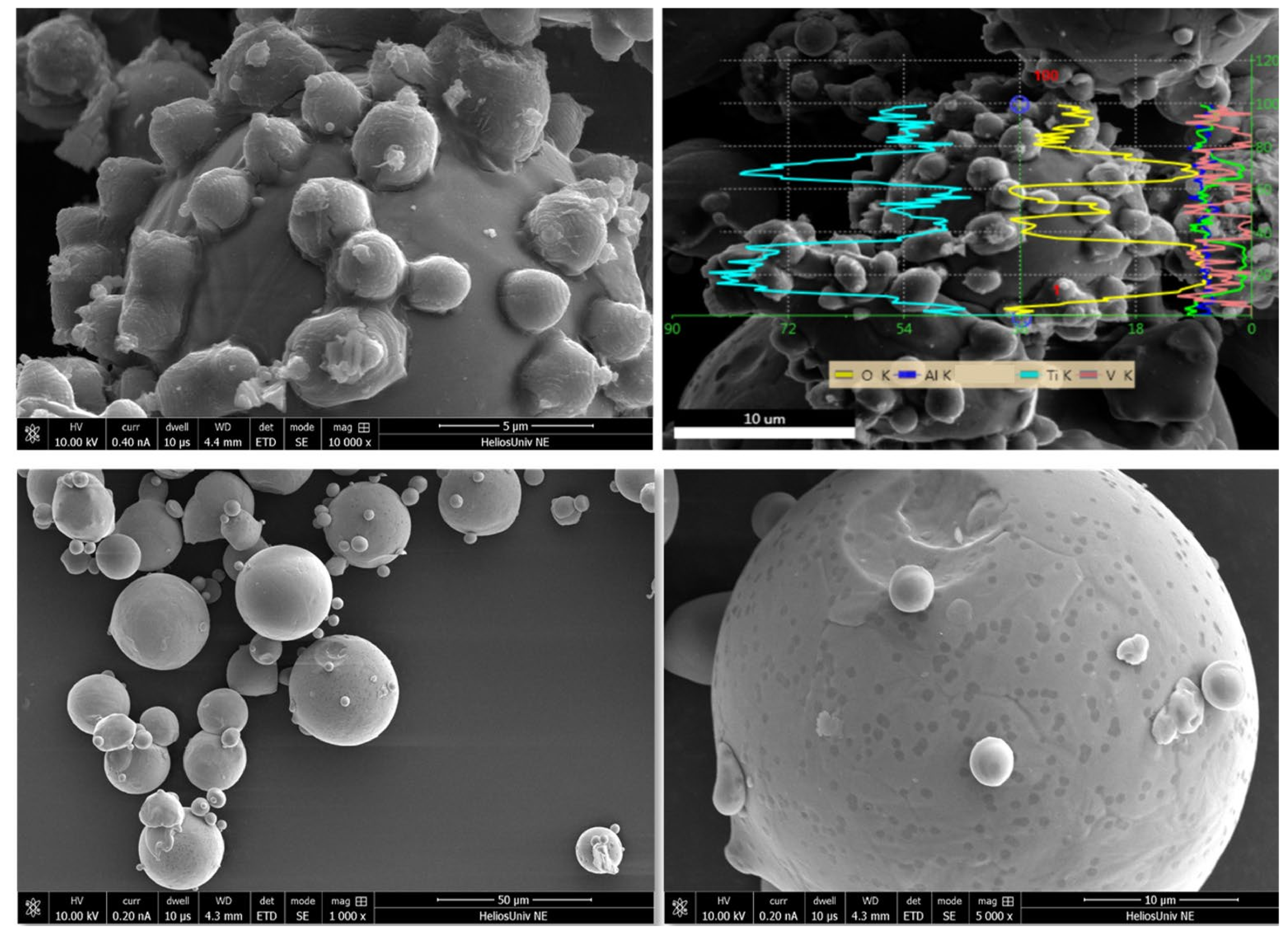

Figure 2. (Top) Gas processed Ti64 particle with isolated TiO_2 on the surface. (Bottom) Removal of TiO_2 resulting a clean/smooth Ti64 particle.

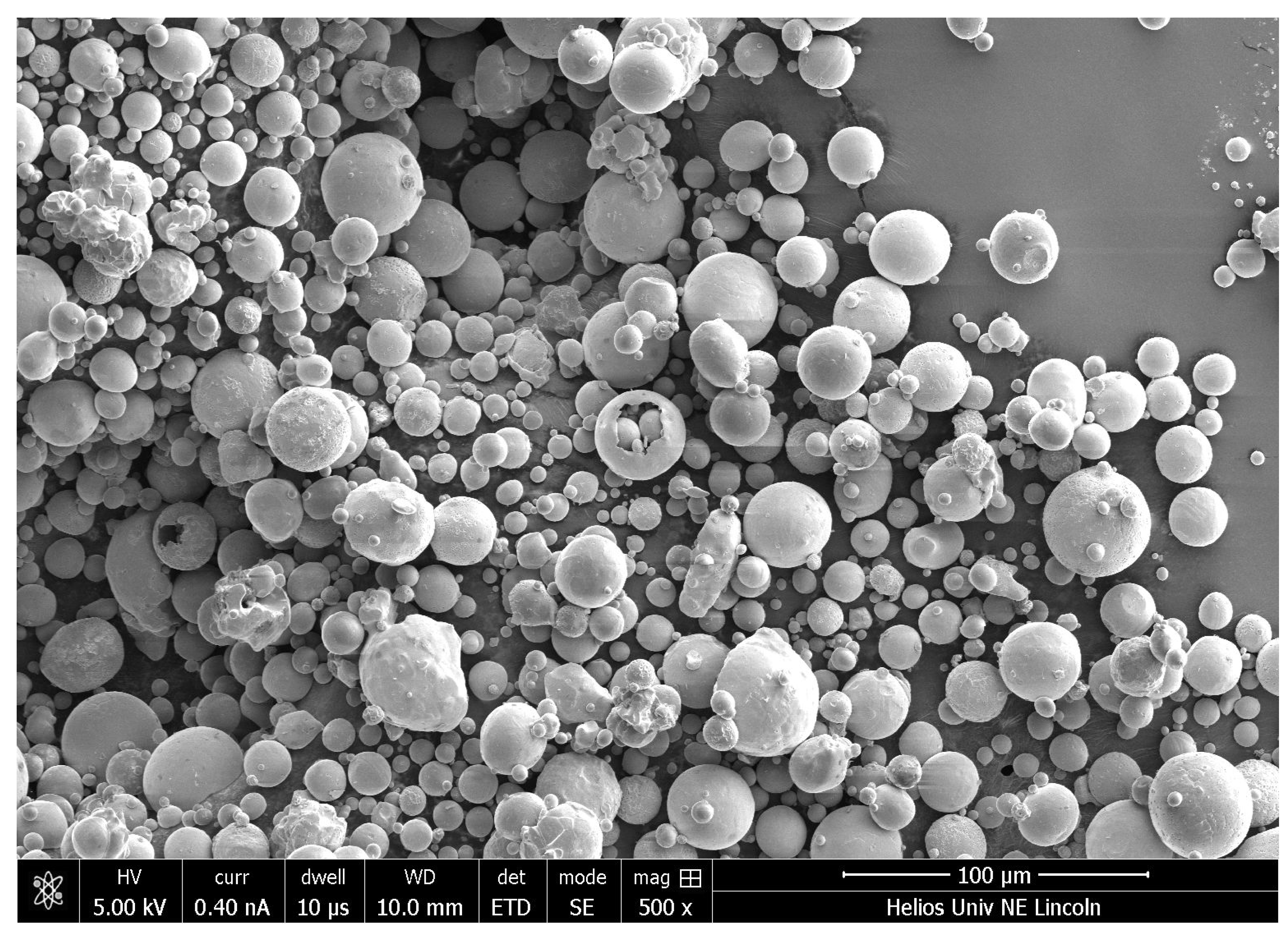

Figure 3. Processed Ti64 powder showed slight variation in uniformity. Some particles experienced more reaction during the gas phase process than the others.

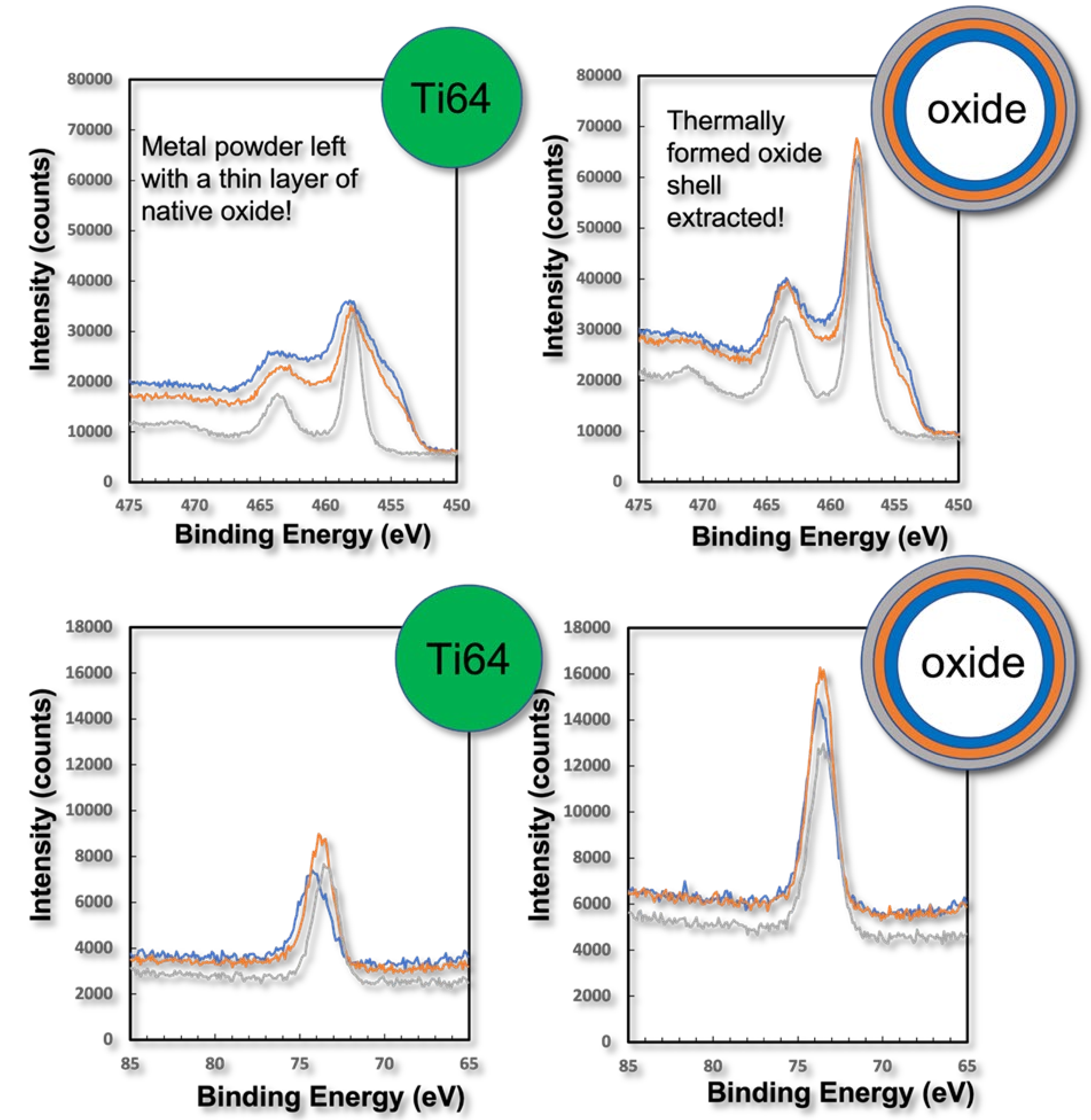

Figure 4. X-ray photoelectron spectroscopy (XPS) of reconditioned Ti64 powders. (Top) Ti-element with reduced oxide (left) and oxide-rich shells. (Bottom) Al-element with reduced oxide (left) and oxide-rich shells.

Conclusion

The processes explored successfully reduced the oxygen content in Ti64 powders by removing the outer shell of the powders. Further improvements on uniformity, removal of byproducts, and scaling are still needed to increase the quality the final product as well as the usability and scalability of the process.

Acknowledgement

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