



# ALUMINUM ANODIZERS COUNCIL™

## Recycling Of Anodized Aluminum

The [Aluminum Anodizers Council](#) (AAC) asserts that recycling efforts can be maximized by choosing aluminum, which can be infinitely recycled without degradation of its properties, and anodized aluminum is just as recyclable as the metal alone.<sup>[1]</sup> AAC states that, “Recyclability is unaltered by anodizing and no intermediate processing is needed for anodized metal to reenter the recycle chain, unlike thicker organic or plated metallic coatings. Anodized aluminum is the environmentally sound choice for various applications.” Further, that, “The anodized surface is very hard and thus preserves and extends the life of the aluminum product.”

One of the greatest environmental advantages of aluminum is its tremendous recyclability. According to data from the Aluminum Association and the International Aluminum Institute (IAI), about one-third of all aluminum produced in the U.S. and Canada today is from recycled sources. This recycled aluminum requires about 95 percent less energy required to produce aluminum compared to raw materials. The longevity of aluminum speaks for itself with some 75 percent of all aluminum ever produced still being used today.

The global trade association, Alumobility, notes that production of circular aluminum is highly climate friendly. Further, the organization states that “aluminum is used in ways that allow more than 90 percent of what is produced to be recovered for reuse, contributing to a more sustainable end-of-life recycling process. According to the Aluminum Association, a third-party critical-reviewed [life cycle assessment](#) shows that since 1991, the carbon footprint of recycled aluminum production has dropped by 60 percent.

Anodized aluminum is naturally compatible with aluminum recycling. **According to AAC, recyclability is unaltered by anodizing and no intermediate processing is needed for anodized metal to re-enter the recycle chain**, unlike thicker organic or plated metallic coatings. The anodic coating is generated from the base aluminum metal and thus, has essentially the same constituents as the aluminum – Material Safety Data Sheets for anodized aluminum are identical to those for the metal. Anodized aluminum also retains its properties during recycling, compared to plastic, reducing the need for new aluminum while saving energy and minimizing waste.

The anodizing process does not impact aluminum’s recyclability, which makes it ideal for sustainable production. Anodized aluminum is the “naturally green” material, because anodizing accentuates the environmental benefits of aluminum without compromising them, when compared to other materials and processes. Anodizing enhances aluminum and its environmental benefits by using the base metal – the aluminum alloy – to create a thin, extremely strong and corrosion-resistant finish. The durable oxide layer created during the anodizing process preserves and extends the life of the aluminum product and is “recycle-neutral” with minimal use of such materials as volatile organic compounds (VOCs) and heavy metals.<sup>[1]</sup>

The transition to recycled aluminum presents challenges that can be overcome. In Nancy Klein’s article<sup>[2]</sup>, “Driving Anodizing to the Finish Line,” in *Canadian Finishing & Coatings Manufacturing*,

AAC member, Dr. Jude Runge-Nussbaum, Metallurgical Engineer and Surface Scientist, CompCote International said, “Although it seems that recycled aluminum has been with us for many years, the aluminum industry has recently developed new technologies that have improved the quality of recycled alloys, enabling their use for decorative applications. Even with the improved quality of recycled aluminum, anodizers must understand and respond to the impact of variations in recycled content on aluminum microstructure and consequently, anodic oxide growth, by making suitable process adjustments to the anodizing circuit.”

Anodizing contributes substantially to a product’s life cycle and reduces energy demands. By adopting best practices, evaluating surfaces and refining the anodizing process, the aluminum industry can achieve the highest quality recycled, anodized aluminum for use in sustainable products. The wear resistance that anodizing adds to aluminum extends aluminum’s life cycle even further.

According to the *Light Metal Age* article<sup>[3]</sup>, “Why Anodizing is the Most Sustainable Surface Treatment for Aluminum,” written by AAC Member, Dr. Anne Deacon Juhl of AluConsult, post-consumer scrap refers to aluminum products that have been used and are ready for disposal, reuse and recycling. She notes that post-consumer scrap is recycled at a lower amount than production scrap, as the process is more complex and involves multiple steps, including collection, inspection, separation, shredding, and de-coating prior to remelting.

Post-consumer aluminum scrap must be analyzed to determine alloy elements and separate them to maintain quality. The sorting process must be refined to enhance the quality of recycled aluminum. Dr. Deacon Juhl said, “To improve the quality of post-consumer scrap, designers, engineers, and architects should be encouraged to develop products that are easy to disassemble and recycle,” and added, “In this context, specifying an anodized surface treatment is recommended, as it is a green surface treatment that is well suited to recycling.”

Dr. Deacon Juhl asserts that anodizing is by nature a green surface treatment, however, certain alloys made with a high amount of recycled content could contain iron, copper, and zinc impurities. Increased iron can lead to a darkened anodic coating and can decrease corrosion resistance in connection with other alloying elements. She noted that an increase in zinc could cause spangling of the surface during etching, and that higher copper and zinc can lead to intergranular corrosion (IGC), thus recycled aluminum alloys must be carefully inspected to ensure they contain low levels of impurities.

Deacon Juhl noted that paint, coatings, lacquer, and other organic coatings make recycling more difficult because they must be thermally removed prior to remelting and are partly responsible for dross formation during melting. The thermal de-coating process to remove organic contamination results in waste products that release CO<sub>2</sub> into the atmosphere. Thus, she concludes that anodizing is the more environmentally friendly choice for more sustainable and recyclable aluminum.

In the ET ’24 paper<sup>[4]</sup>, “Five Critical Mistakes to Avoid with Sustainable Anodized Aluminum,” co-authored by Dr. Deacon Juhl and green marketing specialist Amelie Haupt, there are specific pitfalls involving recycling anodized aluminum that must be addressed in order to maintain product quality and ensure sustainability. Purchasing recycled aluminum without knowing its source and production process can have environmental consequences. They state that obtaining certifications

on the aluminum's supply chain and carbon footprint verifies the recycled aluminum's environmental impact and supports a transparent supply chain.

A lack of knowledge about alloying elements present in recycled aluminum can impact the anodizing process and resulting anodized finish. Alloying elements will affect the anodizing process, and an account of all elements present gives a complete picture of the recycled material's composition. The authors note that alloying elements can impact mechanical properties and anodizing appearance and impact the quality of the aluminum.

Dr. Deacon Juhl states that analyzing microstructure variations and surface characteristic differences between primary and recycled aluminum is important, as this affects anodized aluminum quality and final surface results. She asserts that trace elements found in recycled aluminum can alter surface appearance, such as zinc, which can also cause surface finish defects to increase. Mitigating trace element contents by augmenting the aluminum alloy with other elements can help eliminate surface finish issues during the alkaline etching process.

The authors conclude that anodizing plays a key role in promoting aluminum's sustainability and that anodizing enhances the natural oxide layer on aluminum surfaces for increased corrosion resistance, better aesthetics, and a superior surface for adhesion. When evaluating aluminum, the full recyclability contributes to resource conservation and waste reduction, with all of this working to promote a more sustainable aluminum industry.

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Example of anodized aluminum where recycled aluminum was used.

### **Building & Construction Application**

The Mirabella Retirement Community, Portland, Oregon<sup>[5]</sup>

Company: SAPA Extrusions                      Architect Firm: Ankrom Moisan

Customer: Hoffman Construction          Medium: Aluminum Extrusions

The Mirabella Portland retirement community is anticipated to reach Leadership in Energy and Environmental Design (LEED) Platinum Certification. Sapa Architectural Products provided the black anodized custom-designed aluminum railing system, aluminum trellis and barbeque canopy to match. The trellis was anodized black to be consistent with the railing system. Among the many reasons an anodized finish was chosen for the Mirabella product, anodizing is recognized as a medium for extending aluminum's life and will never rust. Anodized aluminum will not show "wear" under ultraviolet (UV) and salt-water exposure. The recyclability of aluminum and the fact that the extruder (at the time of this construction) used 25 percent recycled aluminum content, contributing to the project's LEED Platinum certification.

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According to the Aluminum Association's Decarbonization Roadmap<sup>[6]</sup>, "Additionally, recycling more aluminum more efficiently can dramatically speed up industry emissions reductions." Their Optimal Scrap Utilization scenario estimates that an additional 160 million metric tons of CO<sub>2</sub>e emissions reductions can be achieved by 2050, on top of the 127 million metric tons of reduced CO<sub>2</sub>e emissions assumed under the Constrained Scrap Utilization scenario. Such a total reduction

in CO<sub>2</sub>e emissions by using recycled aluminum from scrap is cited as equivalent to taking more than 68 million cars off the road for a year.

The Aluminum Association states that to support the transition to lower carbon, domestic aluminum production, federal and state policymakers and regulators must, among other steps, support policies and technologies that drive increased aluminum recycling like better scrap sorting, recycling incentive programs and closed-loop material management, as well as providing R&D incentives for clean aluminum production technologies in scrap melting among other areas.

## References

1. AAC Website at: <https://anodizing.org/page/anodizing-environmental-advantages>
2. “Driving Anodizing to the Finish Line,” Nancy Klein, *Canadian Finishing & Coatings Manufacturing*, May/June 2023, p. 20.
3. “Why Anodizing is the Most Sustainable Surface Treatment for Aluminum,” Dr. Anne Deacon Juhl, AluConsult, *Light Metal Age*, May 23, 2022, online at: <https://lightmetalage.com/news/industry-news-surface-finishing/why-anodizing-is-the-most-sustainable-surface-treatment-for-aluminum/>
4. Dr. Anne, Deacon Juhl and Amelie Haupt, “Five Critical Mistakes to Avoid with Sustainable Anodized Aluminum,” *Proceedings of the Thirteenth International Aluminum Extrusion Technology Seminar (ET '24)*, Volume 2, pp. 511-514, May 2024, Orlando, Florida, Extrusion Technology for Aluminum Profiles Foundation.
5. AAC Website at: <https://anodizing.org/page/anodized-aluminum-applications>
6. “Pathways to Decarbonization: A North American Aluminum Roadmap,” the Aluminum Association, online at: <https://aluminum.org/Decarb>.