

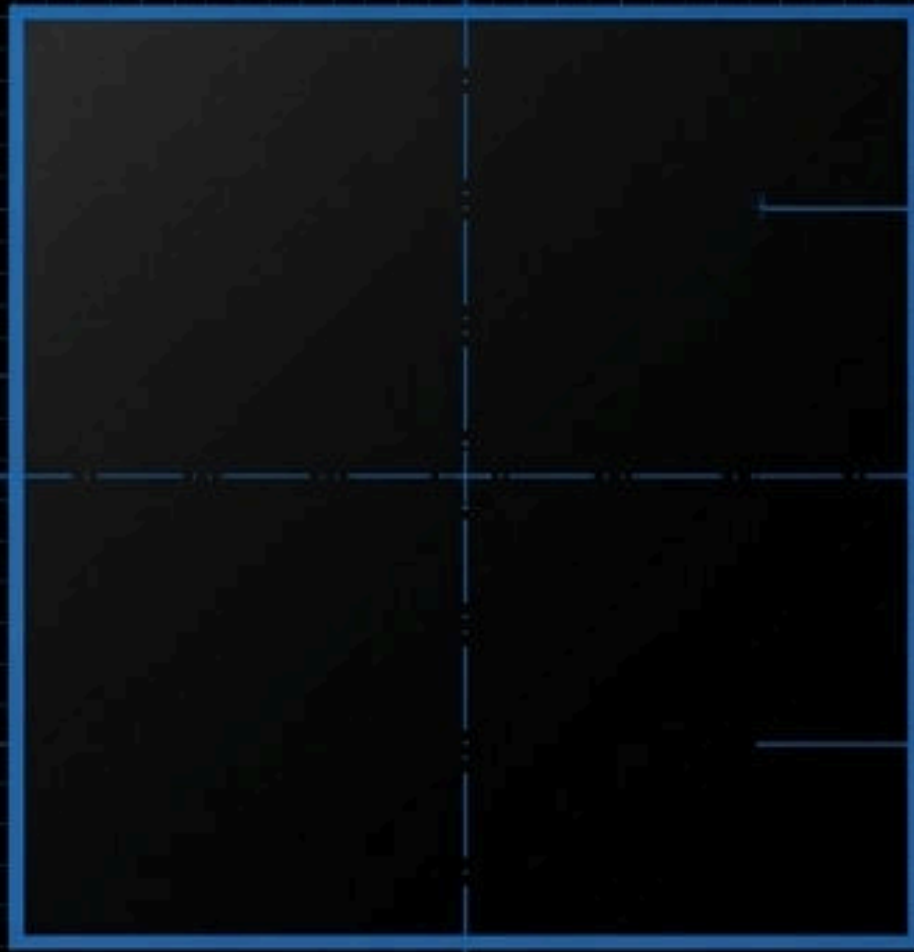
Diagnosing White Spots on Black Anodized Aluminum

Understanding the metallurgical physics behind cosmetic variations in cast tooling plates.

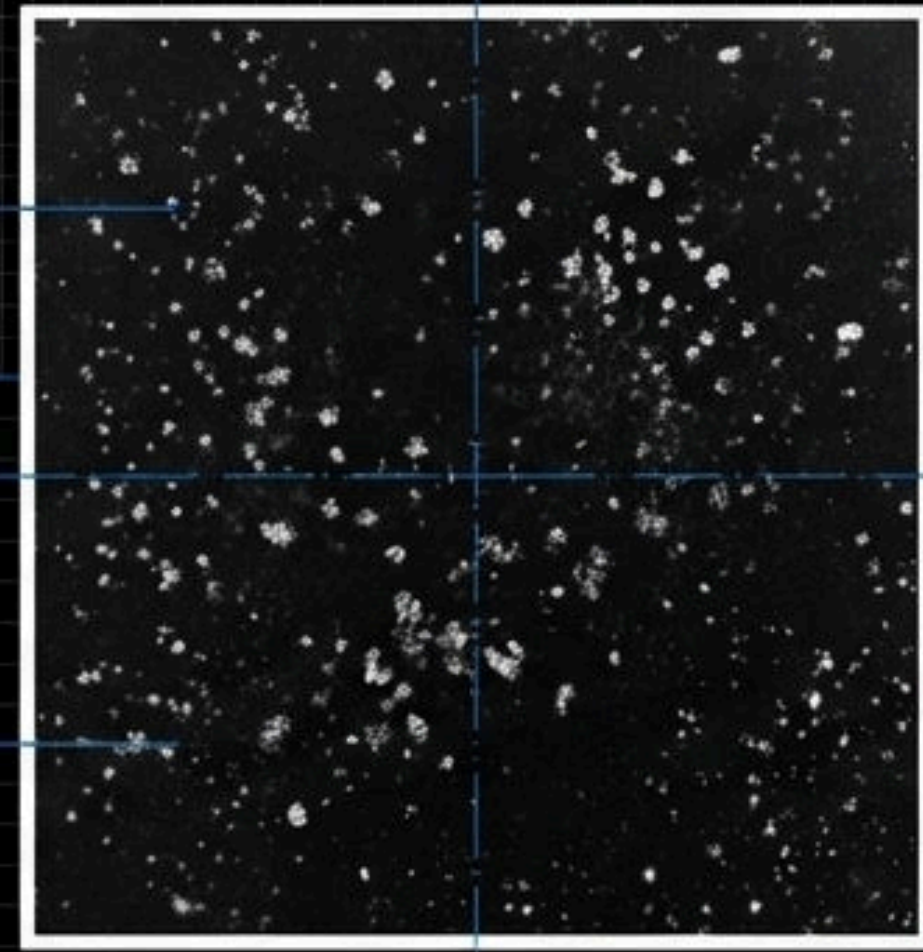
Based on metallurgical analysis by Anna Otto.

*A*EROSPACE
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The Defect Myth: Process Failure vs. Material Reality



The Cosmetic Expectation.

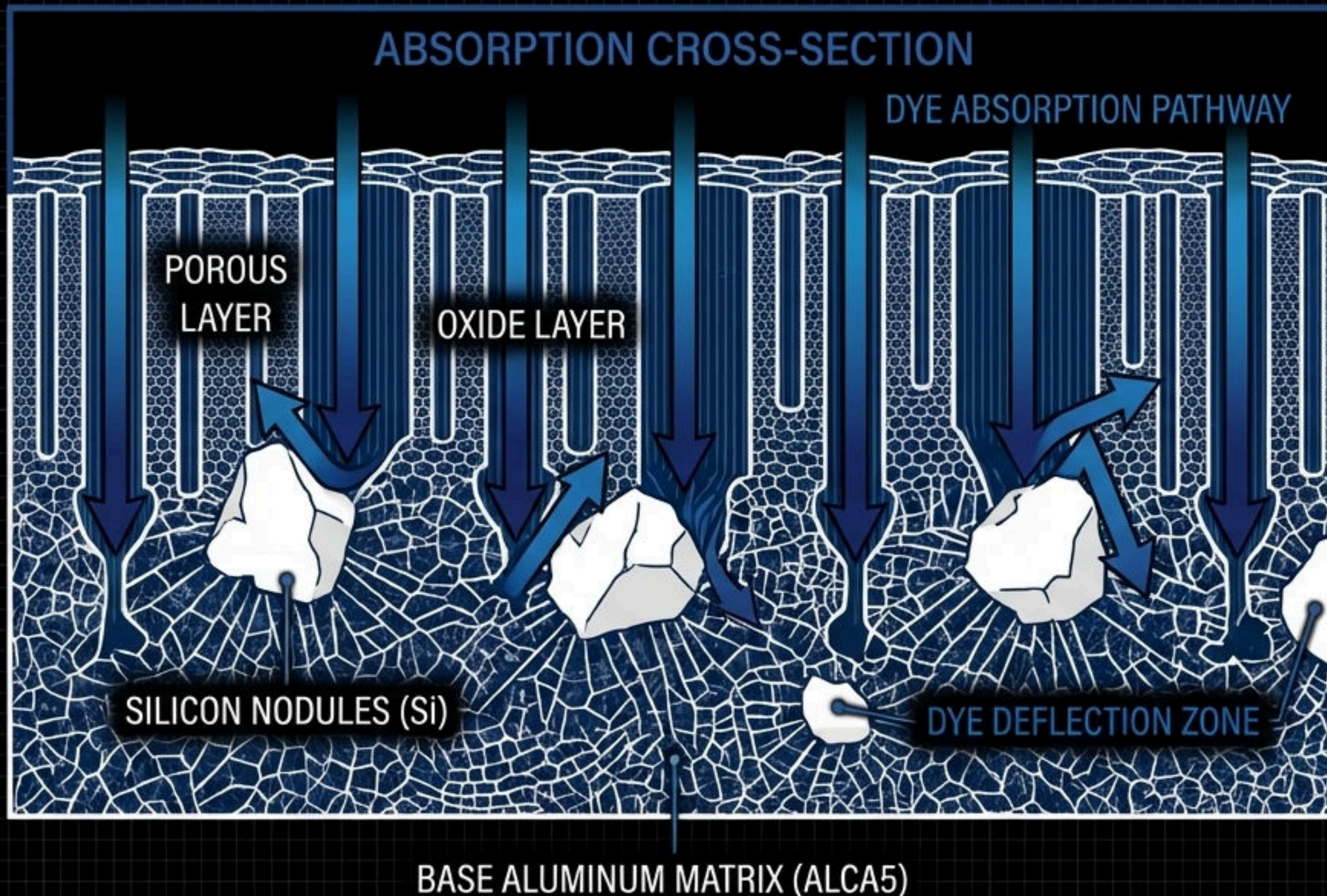


The Physical Reality.

When white spots appear on cast aluminum tooling plates (like ALCA5), the immediate assumption is a failure in the anodizing process. The reality is metallurgical.

White spotting is fundamentally driven by the inherent composition of the material—not a defect in finishing.

The Microscopic Blueprint: Silicon vs. Aluminum



Cast plates like ALCA5 and MIC-6 require higher silicon content than wrought alloys.

Aluminum: Converts to an oxide layer that readily acts like a sponge, absorbing dye.

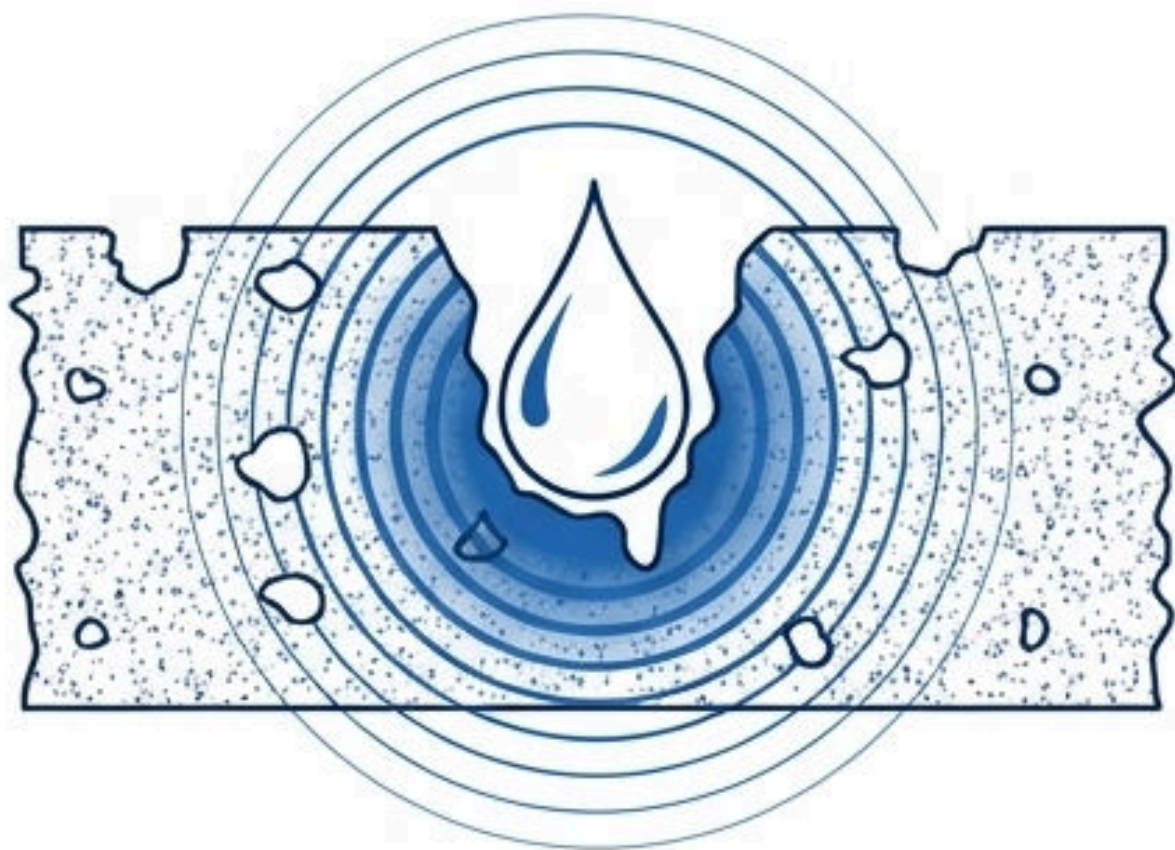
Silicon: Remains inert. It does not anodize and cannot absorb dye.

The Result: Silicon-rich areas remain light, appearing as white or gray speckling heavily contrasted against the black background.

Secondary Drivers: The Porosity Trap and Inclusions

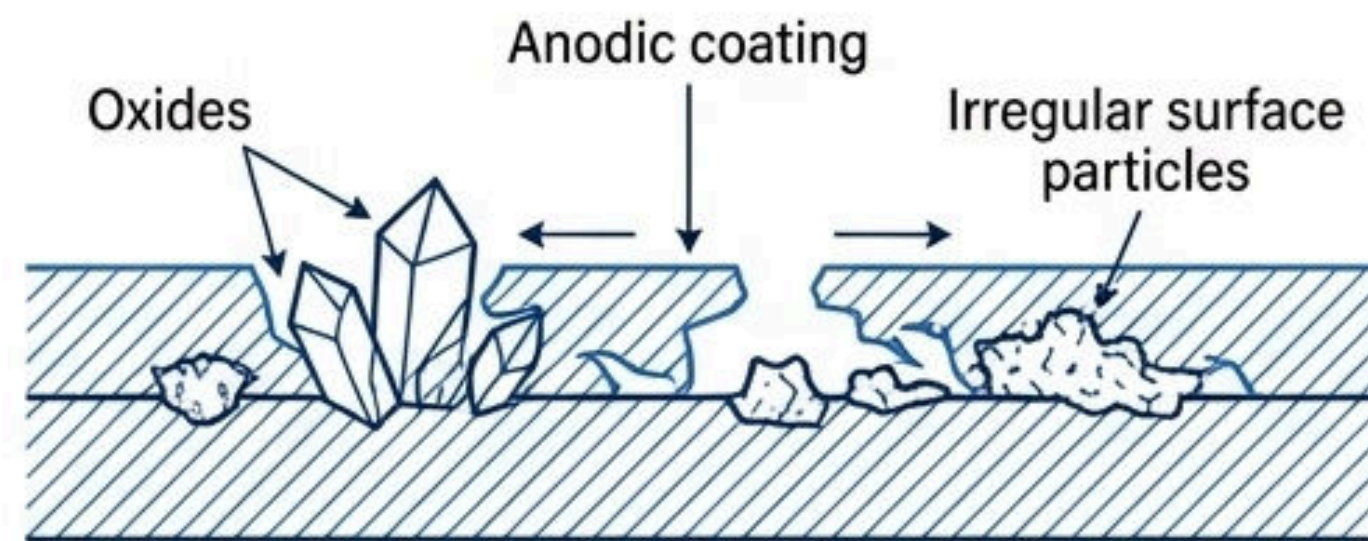
Contributing Factors Dashboard

Microscopic Voids



Microscopic Voids: Cast materials inherently contain trapped gases and voids. During anodizing, these pits trap chemical solutions and resist dye penetration, resulting in uneven, freckled absorption.

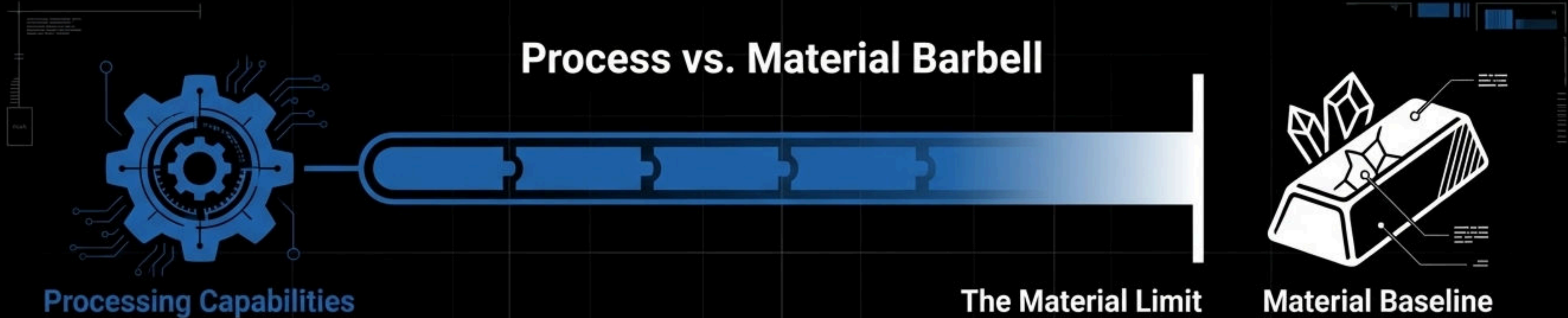
Embedded Contaminants



Embedded Contaminants: Surface smut, impurities, and oxides can resist the anodizing process if not fully addressed, appearing as visible white defects.

The Limits of Chemical Pre-Treatment

Processing plays a role, but it cannot override base metallurgy. To minimize (but not eliminate) silicon spotting on cast aluminum, an aggressive pre-treatment protocol is required.



Required Mitigations



Aggressive etching to remove surface impurities.



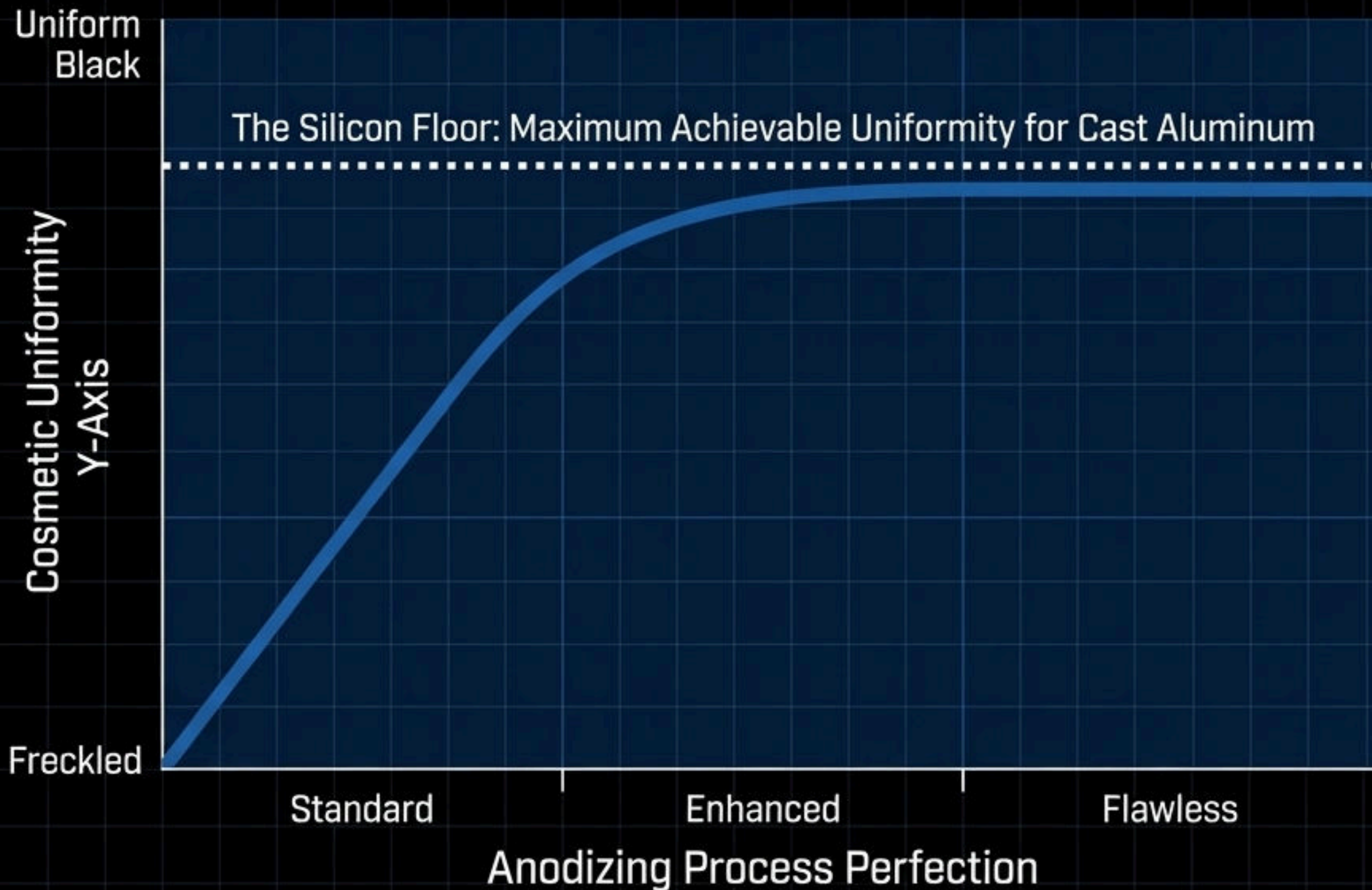
Double desmut cycles (typically Nitric Acid + Ammonium Bifluoride) to target silicon.

Amplifying Factors



Thin anodic coatings (which absorb less dye) or inconsistent sealing will make the inherent cosmetic variations of cast metal far more visible.

The Expectation Curve: Process Cannot Overwrite Physics



Even with a flawless etch, double desmut, and perfect sealing, cast aluminum will never anodize as uniformly as wrought aluminum.

Black dye simply maximizes the visual contrast of these unavoidable physical realities.

Cosmetic vs. Functional Specification Matrix

Select your material based on the ultimate requirement of the component.

Criteria	Cast Tooling Plates (ALCA5, MIC-6)	Wrought Alloys (6061-T6)
Silicon Content	High (creates spotting)	Low (absorbs dye evenly)
Primary Strengths	Superior dimensional stability, High machinability	Excellent cosmetic uniformity, High structural strength
Anodize Appearance	Speckled, gray/white spots visible	Smooth, uniform jet-black finish
Recommended Application	Internal functional components	External, customer-facing cosmetic parts

Aligning Material Specifications with Intent

1. Acknowledge the Physics

White spots on black ALCA5 are caused by silicon and porosity, not finishing failures. Set cosmetic expectations accordingly.

2. Specify Processing

If cast plates must be used and anodized, explicitly specify enhanced pre-treatment (etch + double desmut) to minimize spotting.

3. Pivot for Cosmetics

If a flawless, uniform black finish is a critical requirement, abandon cast plates and specify 6061-T6 wrought aluminum.