

Open-Air Spray Coating of Ultrathin Aluminum Oxide for Stable Semiconductor Packaging

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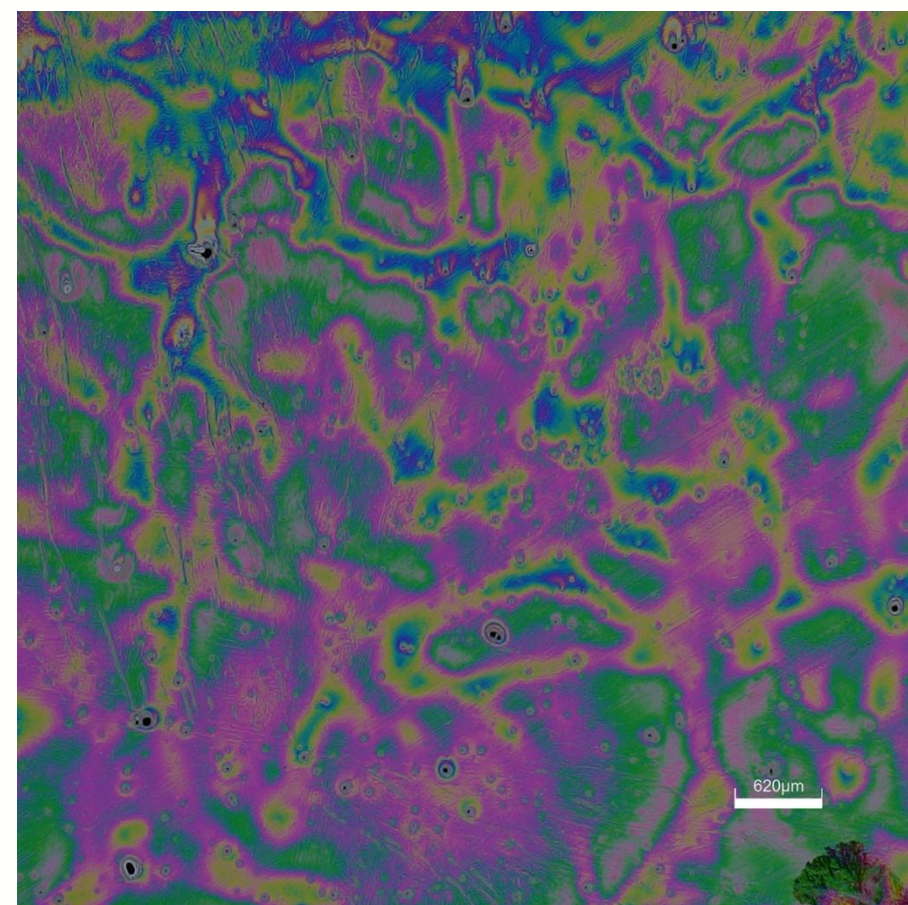
Introduction

What is a cost-effective technique to prevent water vapor damage to semiconductor devices?

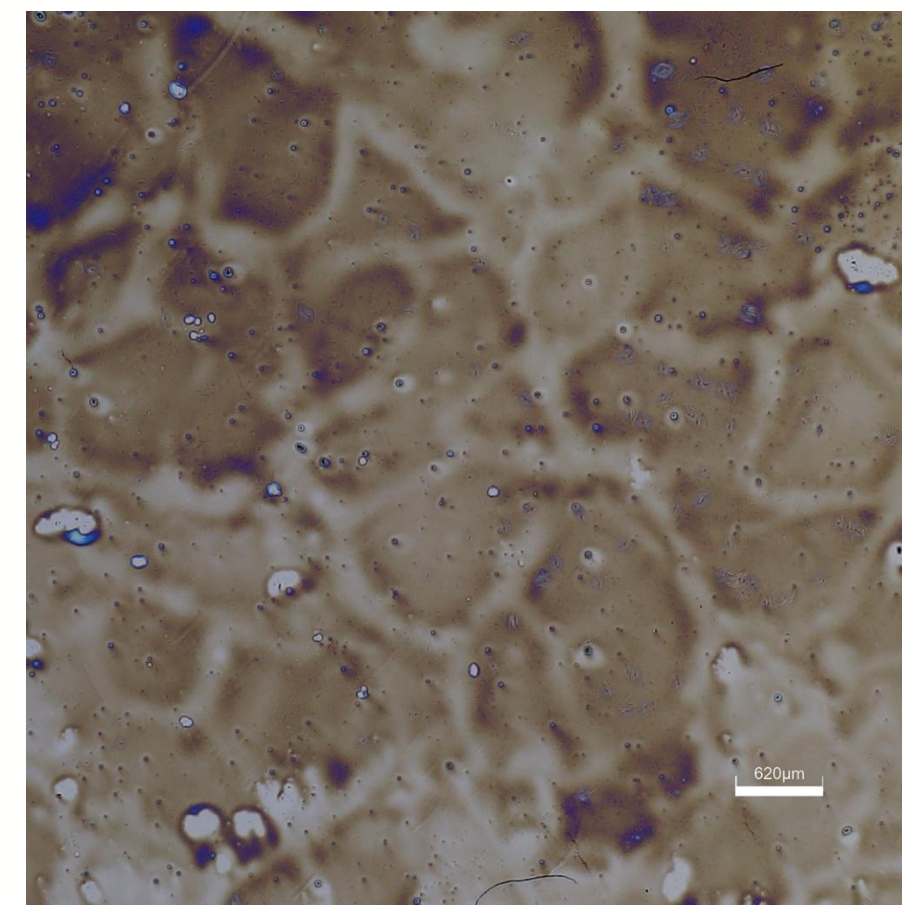
- A solution is to use aluminum nitrate nonahydrate $Al(NO_3)_3$ to create an alumina-based coating. This would be applied using an **open-air spray coater**, a more economical option than vacuum operated procedures typically used in industry. The goal is to ensure that circuit boards exposed to water vapor retain their efficiency rates.

Materials and Methods

- **Open-Air Spray Coating** 1x1 inch silicon wafers with $Al(NO_3)_3$ and ethanol solution three times to create a thin film of ~300 nm.
- Allow the ethanol on the film to evaporate for 20 minutes.
- **Anneal** samples on a 200 C° hot plate for 15 minutes to form an oxidized film on the surface of the silicon wafer.
- Boil samples in water for 10 minutes to simulate 'aging'.
- **GD-OES and P16+ Profilometer:** Characterize samples to find the thickness and composition of each film.



Spray-coated film before annealing.



Spray-coated film after annealing.

Methodology

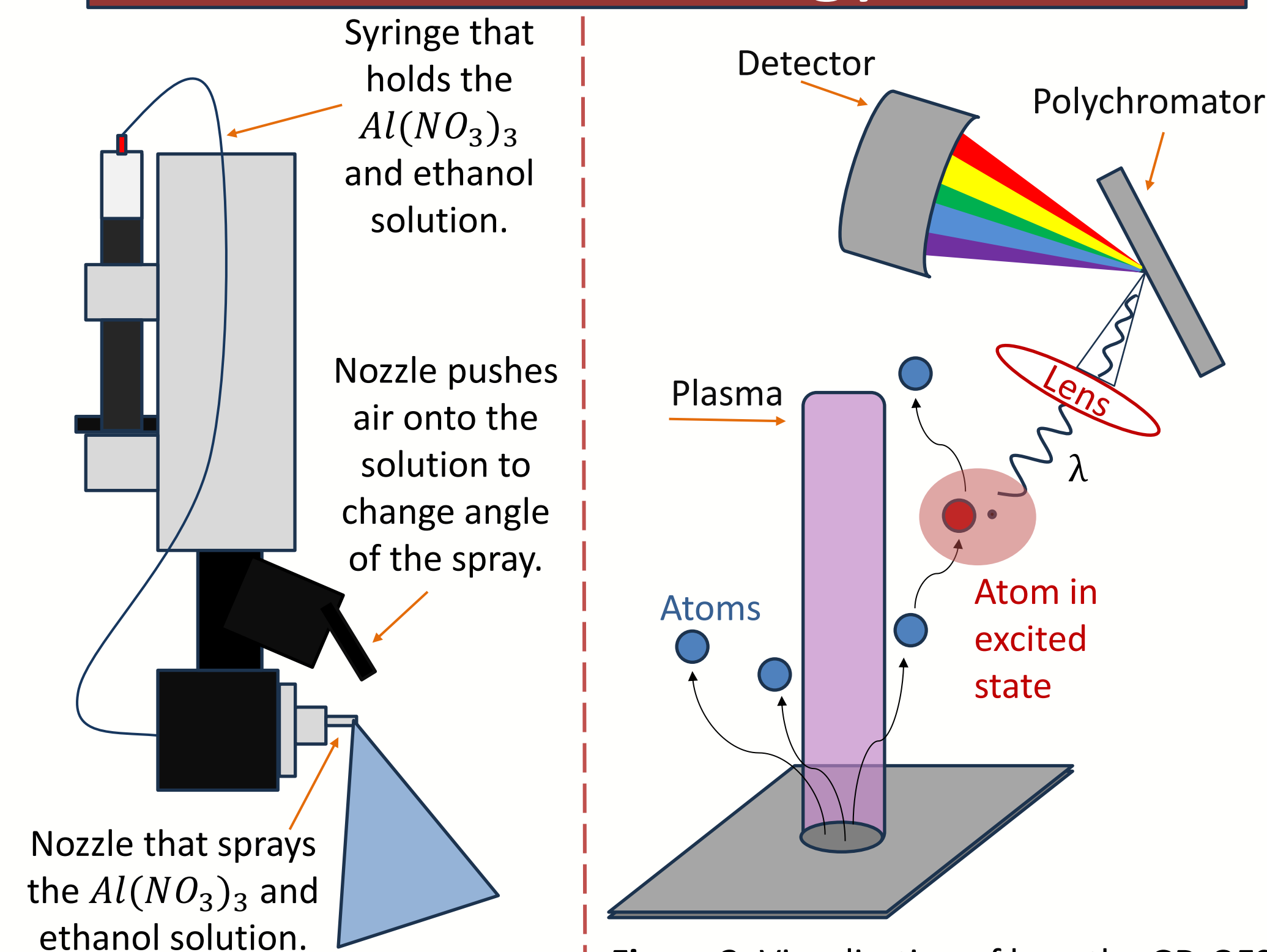


Figure 1: Open-air spray coater.

Figure 2: Visualization of how the GD-OES detects the elemental composition of films.

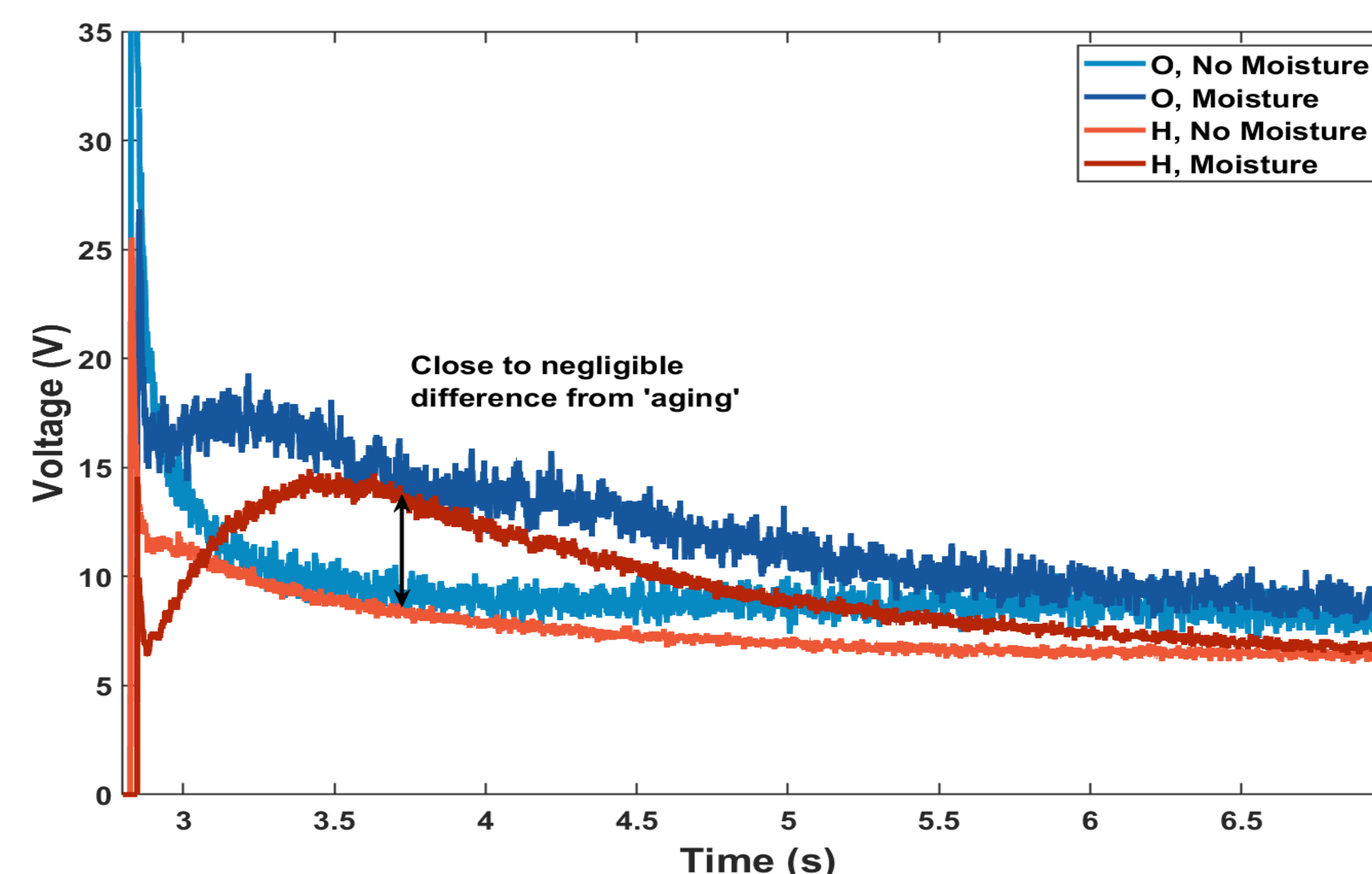


Figure 3: Oxygen and hydrogen absorbed in moisture exposed sample is minimal.

Results

- Thin film thickness of ~300 nm was coated using the open-air spray coater.
- The GD-OES determined that an oxide coating is formed after annealing a coated wafer.
- Boiled samples showed ample resistance to moisture penetration into the annealed thin film.

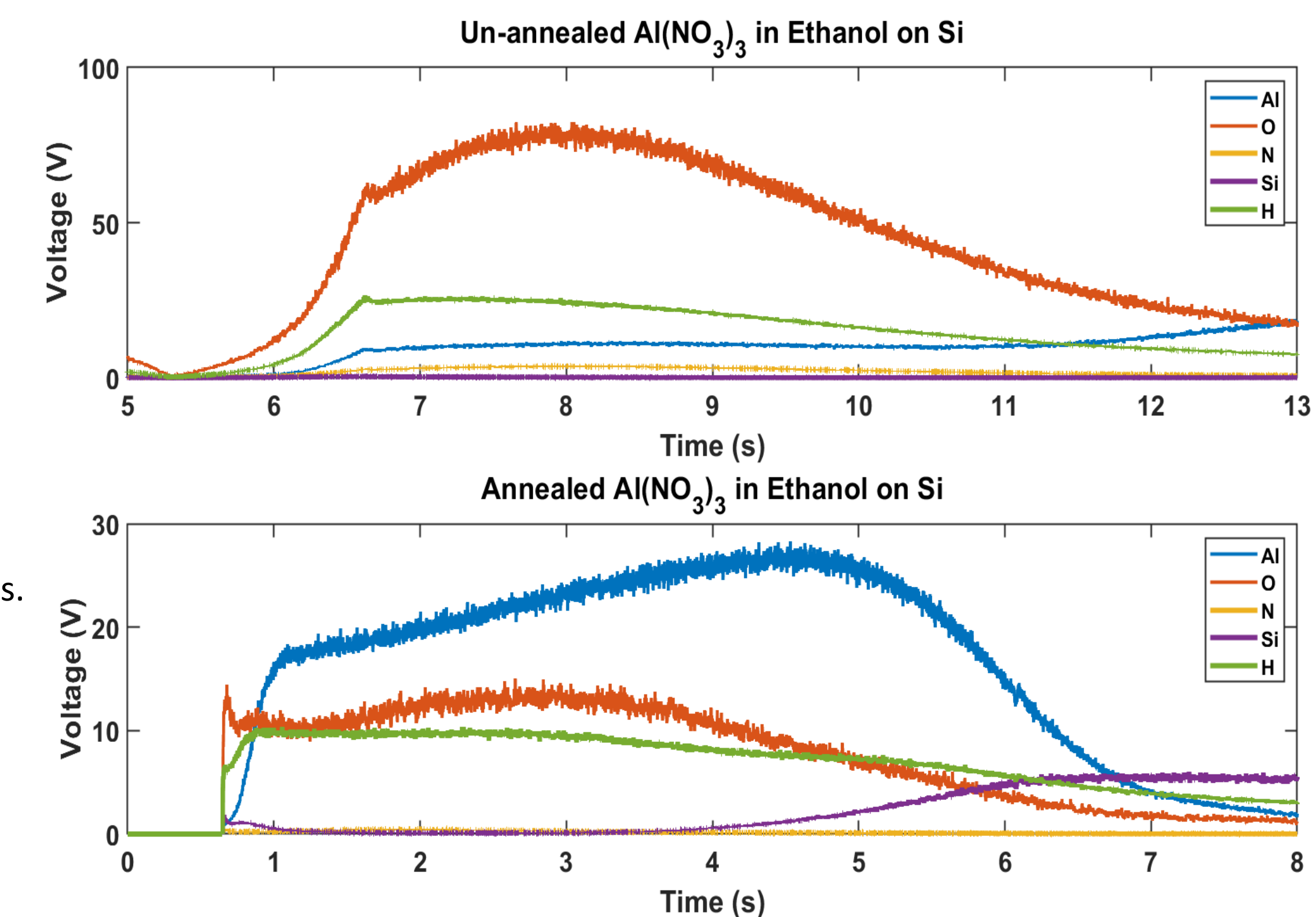


Figure 4: Peak before one second mark shows oxidation on **annealed** surface.

Next Steps

- Coat circuit boards with the $Al(NO_3)_3$ solution and expose these samples to humid conditions.
- The efficiency rate of the moisture exposed coated devices will be compared to an uncoated device.