Introduction to INFICON

Solar Solutions

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INFICON Overview

Global leader and innovator in gas analysis and other sensor technologies and smart manufacturing software for semiconductor industry and other industries.

-> 671m$ revenue

-> 1680 employees

-> Largely self-financed

- ✓ INFICON provides **world-class instrumentation in vacuum applications.** Hold the leading position in most of our addressed global markets
- ✓ Strength is the **innovation** capabilities driven by the centers of competence, and the excellence in customer support with a global Sales, Application and Service organization
- ✓ Significant **organic growth opportunities** through innovation, new market segments and applications. Supported through acquisitions and/or partnerships
- ✓ **Diversified markets** with focus on Semiconductor and other tech markets
- ✓ **Largely self-financed** with a long-term investment and growth focus

Worldwide Footprint

Global presence with competence centers and a global sales, application and service network with more than 1680 employees worldwide

- Global market organization with 7 sales, application & service regions and 20+ local offices
- 3 Main Centers of Competence: Syracuse (US), Cologne (DE), Balzers (LI)
- 8 Smaller Locations with Specialized Competence Centers
- Group in Bad Ragaz (CH)

Single/Multi-Crystalline and Thin Film Solar Cells

INFICON solutions are applicable across the Solar value chain to both single/multi crystalline and thin film based manufacturing processes

Crystalline Solar Cells Value Chain

Polysilicon	Ingot	Wafer	Cell	Panel/Module	Systems

Thin Film Solar Cells Value Chain	Substrate (Glass or Plastic)	Cell	Panel/Module	Systems

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Products

Ingot	Cell	Module	Panel

Industrial gas analyzers and process control sensors

Vacuum gauges and components

Leak detectors and service tools

Thin film controllers and quartz crystals

Advanced process control software

Enabling Manufacturing of Highly Efficient Solar Cells

INFICON Smart sensors and software capabilities can be utilized to produce high energy efficient solar panels while reducing cost and process variance

INFICON Solutions

Sensors	**Software** (Intelligent Manufacturing systems)
Live analytics	Instant monitoring & reporting
Gas, vapor, liquid	Process control & optimization

What is a QCM?

QCM stands for Quartz Crystal Microbalance

Precision Mass Detection with QCM

A quartz crystal is piezoelectric and oscillates at its fundamental resonance frequency of 6 MHz (typical)

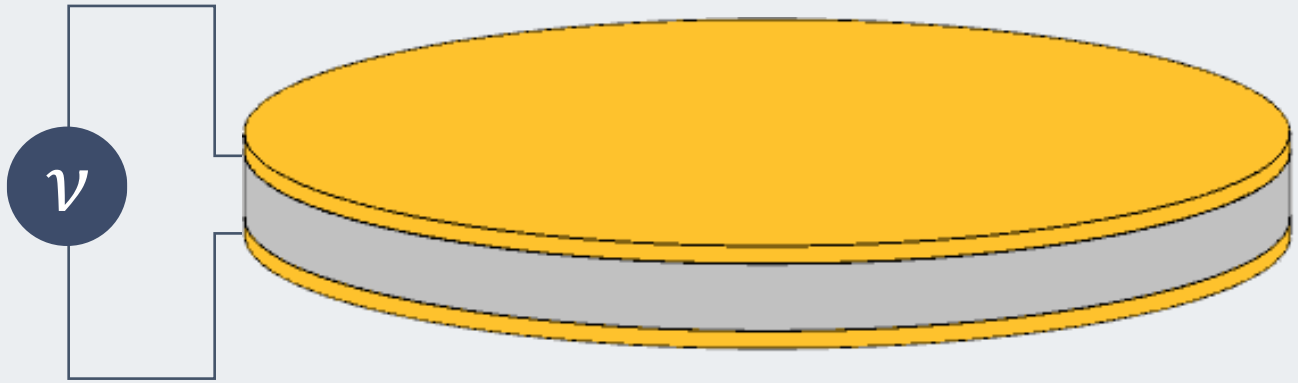
QCMs are **incredibly sensitive** to changes in mass of films on the crystal surface (Nanograms and Sub-Monolayer)

QCM – How It Works

Initial state

Piezoelectric effect

When voltage is applied to the quartz crystal, it oscillates at some frequency based on how thick the crystal is and how much material is on the crystal's surface.

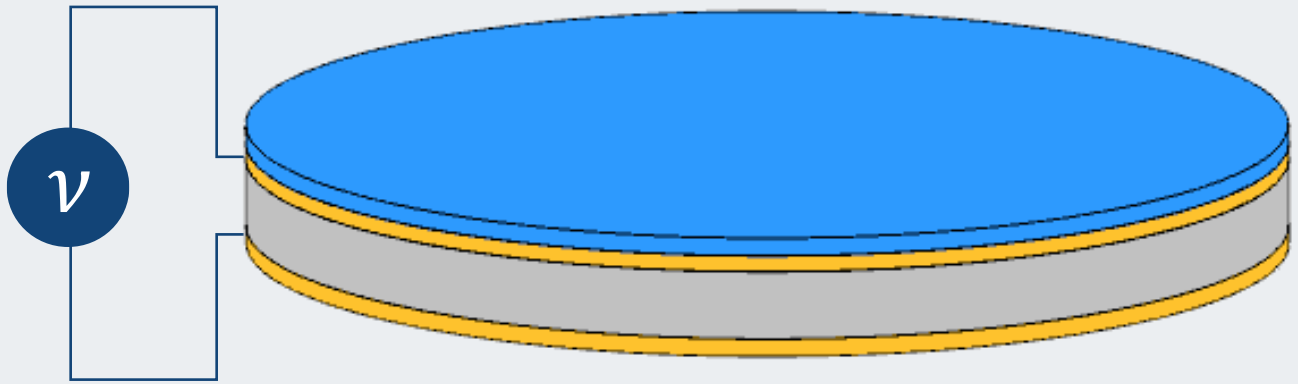


QCM – How It Works

Deposition

Piezoelectric effect

When material is deposited on the quartz crystal, the frequency of the oscillations decreases in proportion to the amount of material deposited onto the crystal's surface. This is known as "mass loading."

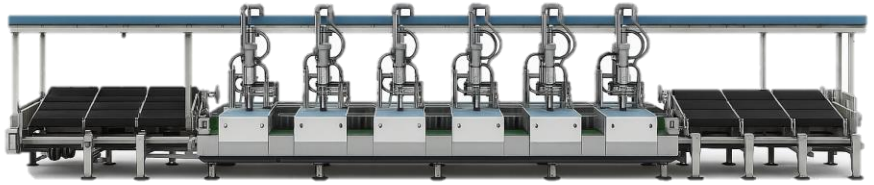


PVD Process Monitoring Using QCM

PVD SPUTTERING | CVD | PECVD | THERMAL EVAPORATION

Polysilicon | Ingot | **Substrate** | Cell | Panel/Module

Cell Processing Coating Step



APPLICATION:

Monitoring rate and thickness

PRODUCT:

IMC300, Rotary Sensor, and Crystals

Key Pain Points

For Sputtering aspect of the PVD, currently uniformity is problematic in this process

Quality Requirements

Homogenous distribution of sputtered material from wafer to wafer

Our Advantage

In process visibility of the material thickness leading to uniform coating and improved product quality

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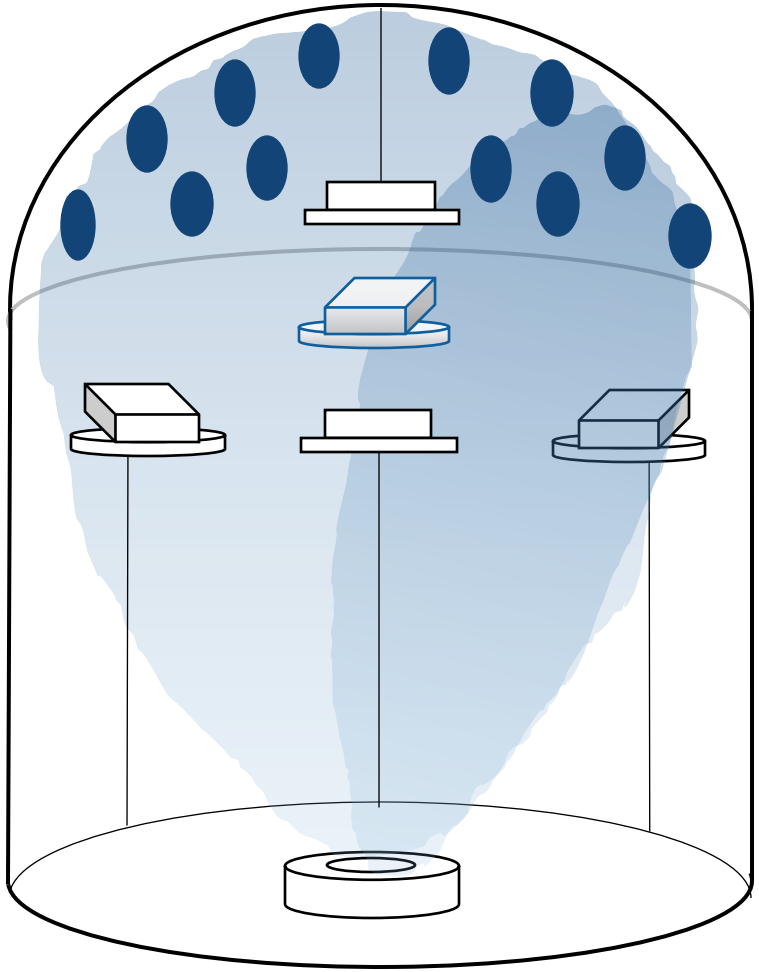
Reduce PVD Process Variation with Multipoint Sensor Monitoring

Solar coating materials often sublime

Leads to time-dependent flux distributions resulting in inconsistent film thickness

Multipoint for multiple sensor rate averaging

- Aggregate rate better represents the flux distribution
- Improved reproducibility and yield



SemiQCM Application Examples

PERC/TOPCon/HJT/IBC - (PE)CVD, ALD

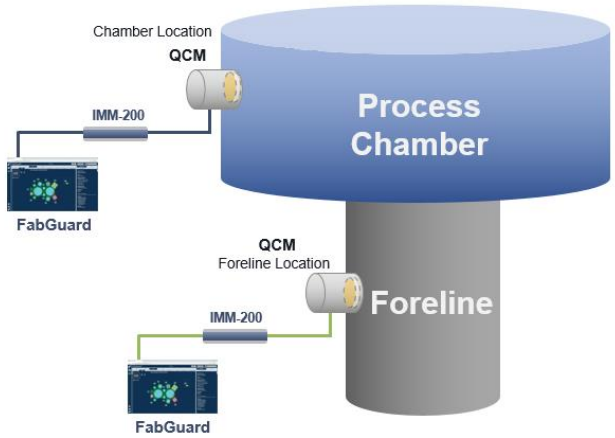
Foreline Installation

1

Precursor monitoring in CVD chamber
- Ampoule depletion and fault detection
- Dep-rate and densification monitoring

2

Precursor and process monitoring in ALD chamber
- Dep rate monitoring
- Ampoule temperature change targeting
- Recipe determination, fault detection
- Ampoule depletion fault detection



Chamber Installation

1

In-Situ Chamber Clean monitoring (PE)CVD
- Anatomy of a clean as detected by QCM
- Deposition and in-situ clean monitoring
- More clean monitoring and fault detection in PECVD dielectric dep

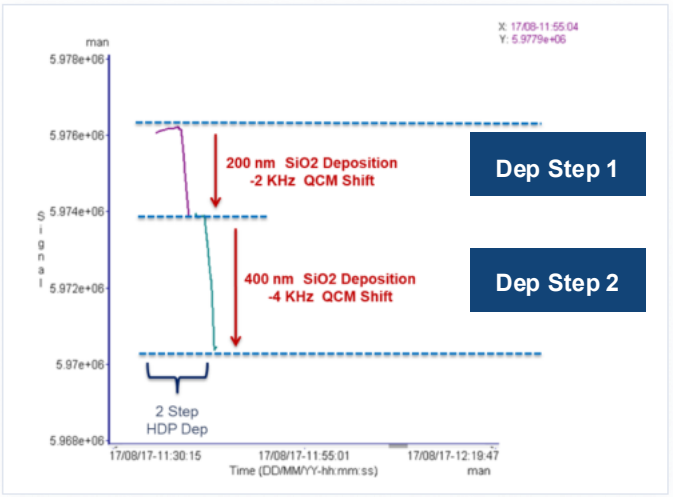
2

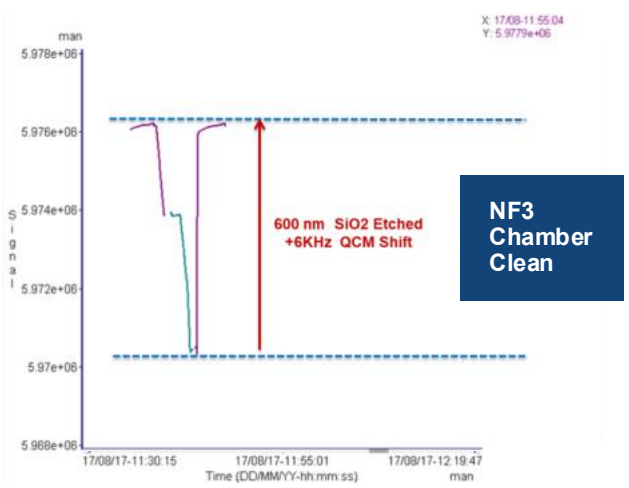
Clean monitoring in PECVD chamber
- Non-plasma based clean, end point monitor

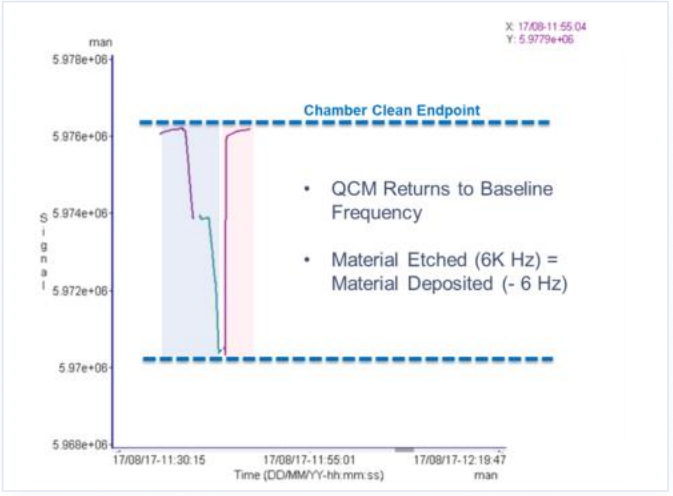
3

RGA+QCM combi sensor

Increase Yield for Cell Deposition Processes with SemiQCM







Start to Finish: Monitoring Wafer Dep and Chamber Clean

PECVD Process Metrology

1. **Accurate measurement of film accumulation on chamber wall**
2. **Correlation to thickness of film deposited on wafer at every step**
3. **Precise determination of chamber clean endpoint**

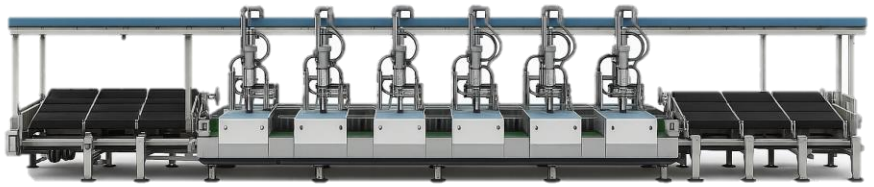
Improve yield with more consistent deposition thickness

Process Monitoring Using RGA

PVD SPUTTERING | CVD/ALD | PECVD | THERMAL EVAPORATION

Ingot | Wafer | **Cell** | Module | Panel

Cell Processing Coating Step



APPLICATION:

Leak check and process monitoring

PRODUCT:

Transpector SPS for (PE)CVD

Transpector XPR 3+

Key Pain Points

Process gas ratios and oxygen levels are critical to production yield

Quality Requirements

Incorrect levels of H_2O and O_2 will negatively effect cell efficiency

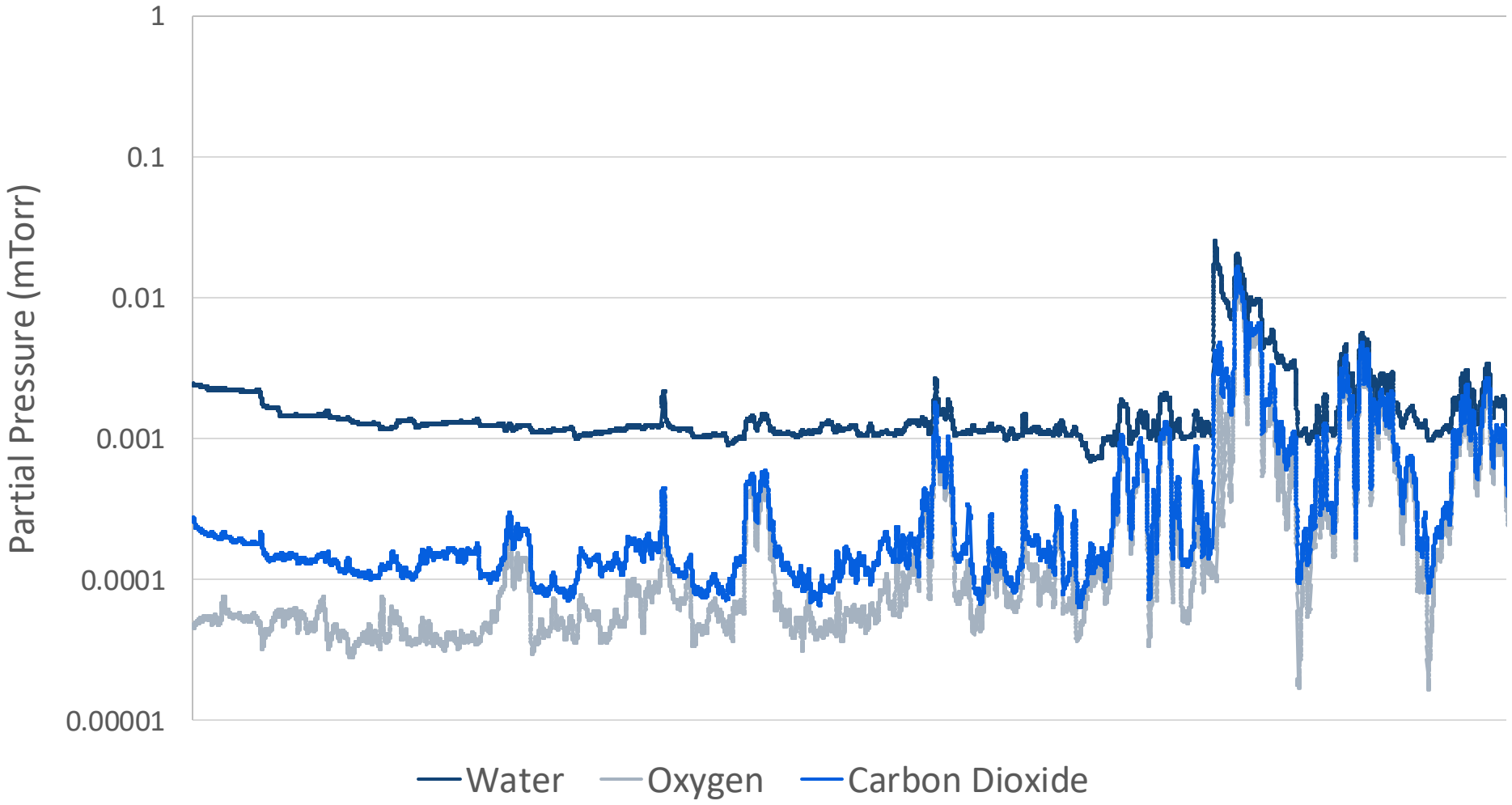
Our Advantage

In process visibility of the residual gases leading to improved process control improves yield and efficiency

AI-generated images created using Microsoft Copilot

Process Monitoring Using RGA

H_2O and O_2 will negatively effect the solar cells efficiency



Thermal Evaporation Process Control Using QCM

PVD SPUTTERING | CVD | PECVD | **THERMAL EVAPORATION**

Ingot | Wafer | **Cell** | Module | Panel

Glass/Plastic Substrate

APPLICATION:

Controlling rate and thickness

PRODUCT:

Cygnus® 2, Rotary Sensor and Crystals




Critical Process Steps

Dry process step is vital for improved yield and efficiency

Quality Requirements

Precise control of deposition rates <1 Å/s and thickness of evaporated material from substrate to substrate

Our Advantage

In process visibility and control of the material thickness leading to uniform coating and improved product quality. QCM is industry standard for thermal evaporation.

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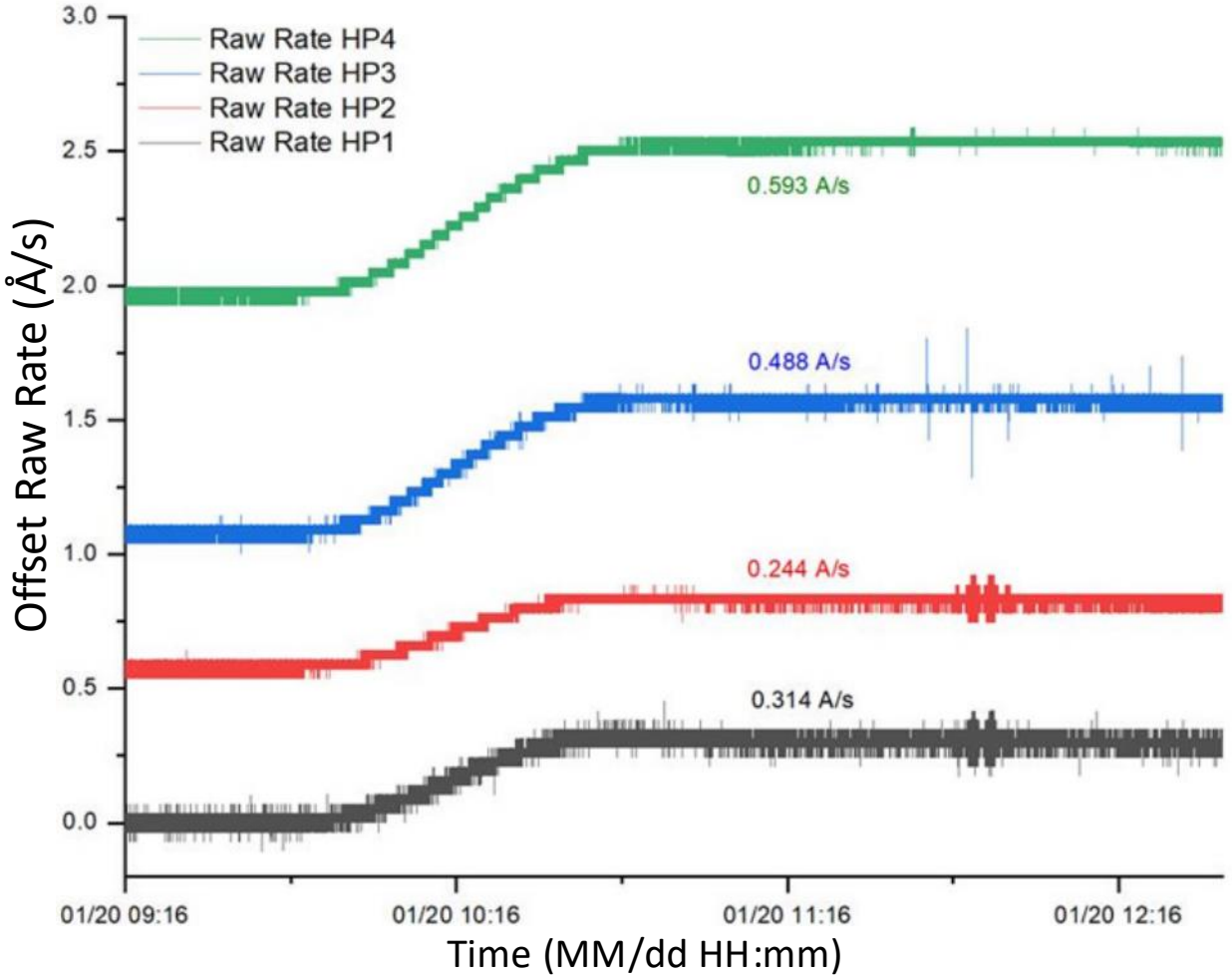
Nearly Six Decades of Thin Film Experience

E.g. AlQ3 sublimation controlled by Cygnus 2 with excellent rate stability

Advanced Thin Film Deposition Control

- **Precise control** of deposition rates for up to six independent sources well below 1 Å/s
- High precision crystals for **organic materials**
- **10x resolution** compared to traditional QCM technology
- **4x crystal monitoring lifetime** compared to traditional QCM technology



Thank You For Your Attention!

Key Takeaways

INFICON provides advanced sensor and software solutions for solar cell manufacturing

- Real-time process monitoring improves efficiency, yield, and product quality
- Free on-demand webinars and application notes
- Request a product demo
- Global presence and customer application support

INFICON

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