# Stability Testing using Low-Cost Environmental Chamber

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## Background

Stability testing of passivated contacts is crucial for ensuring long-term performance of solar cells. Molybdenum oxide is gaining interest as a material used as a hole-selective contact. With emerging methods of depositing the material, it becomes mandatory to understand the adverse effects the atmosphere has on solar cells.

## Motivation

- Large scale industrial chambers are not ideal for smaller research samples as energy and time is wasted, and experiments cannot be run simultaneously with other groups

## Aims

- To find a cheaper and more efficient method for conducting temperature-humidity tests
- To investigate the effects of humidity and temperature on samples with $MoO_x$ deposited via Thermal Evaporation or ALD

## Results

### Chamber Performance

- ~ 10 min temperature ramp up from R.T.P.
- Stabilisation time of ~ 1 min after closing lid
- Maintains 85 ± 5 ◦C and 85 ± 5 % R.H.

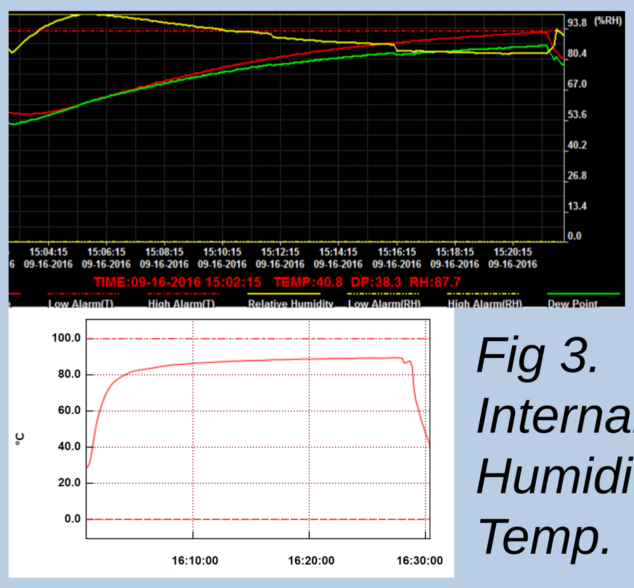

*Fig 3. Internal Humidity Temp.*

### Stability Characterisation

- $MoO_x$ samples degrade at accelerated rate. Immediate lifetime decreases from 1 ms to less than 200 us within 15 s, further decreasing to negligible values
- FTIR analyses indicates the loss of passivation layer, supported by evidence of decreasing Mo peak intensities and PL counts

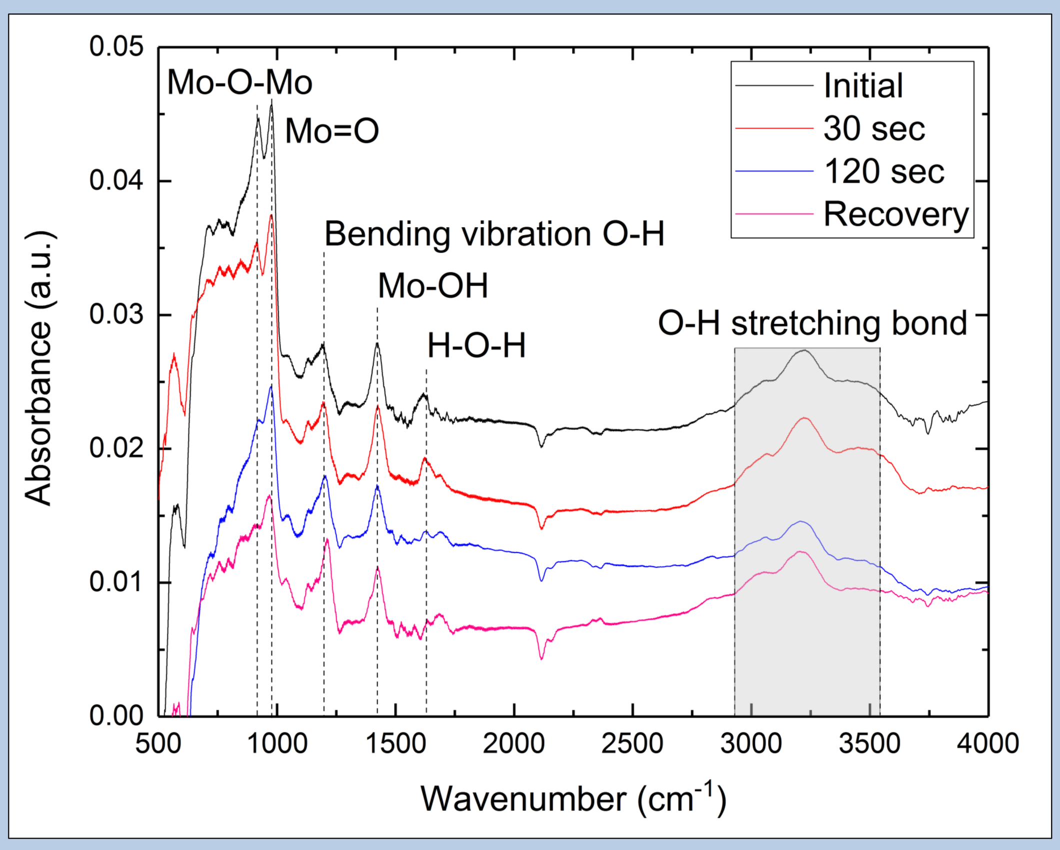


*Fig 4, FTIR signal of $MoO_x$ after total time*

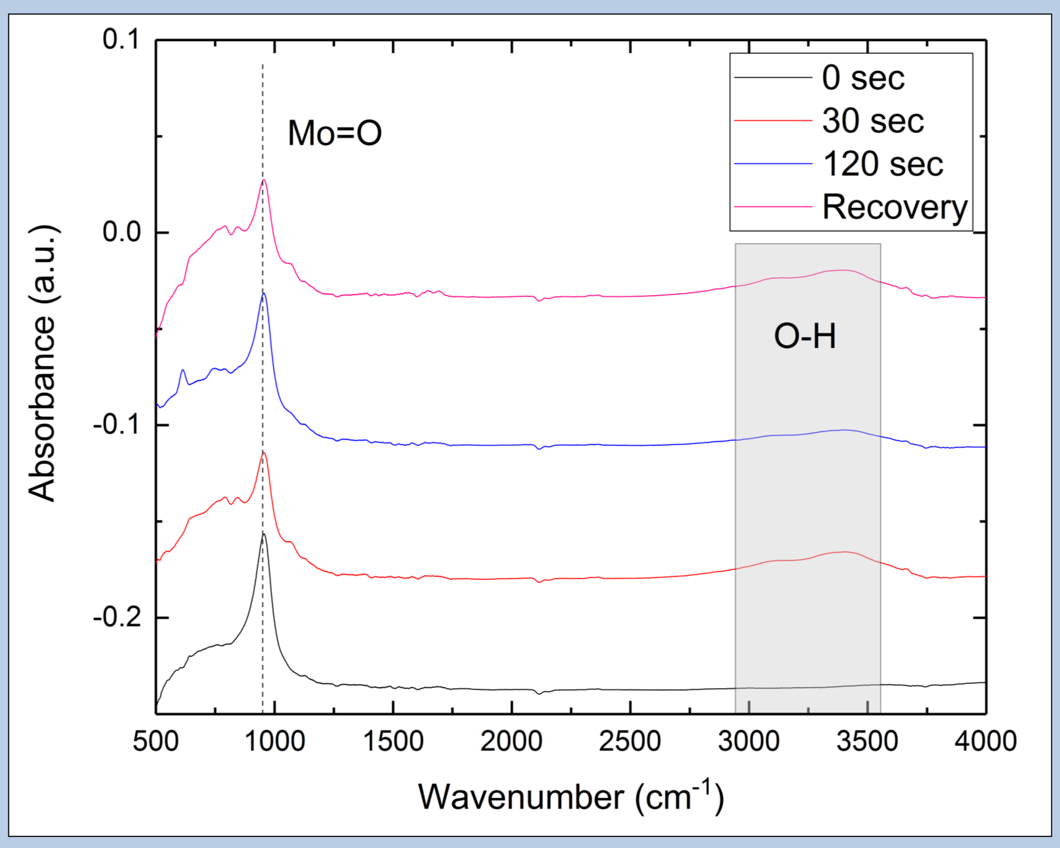


*Fig 5, Processed signal of $MoO_x$*

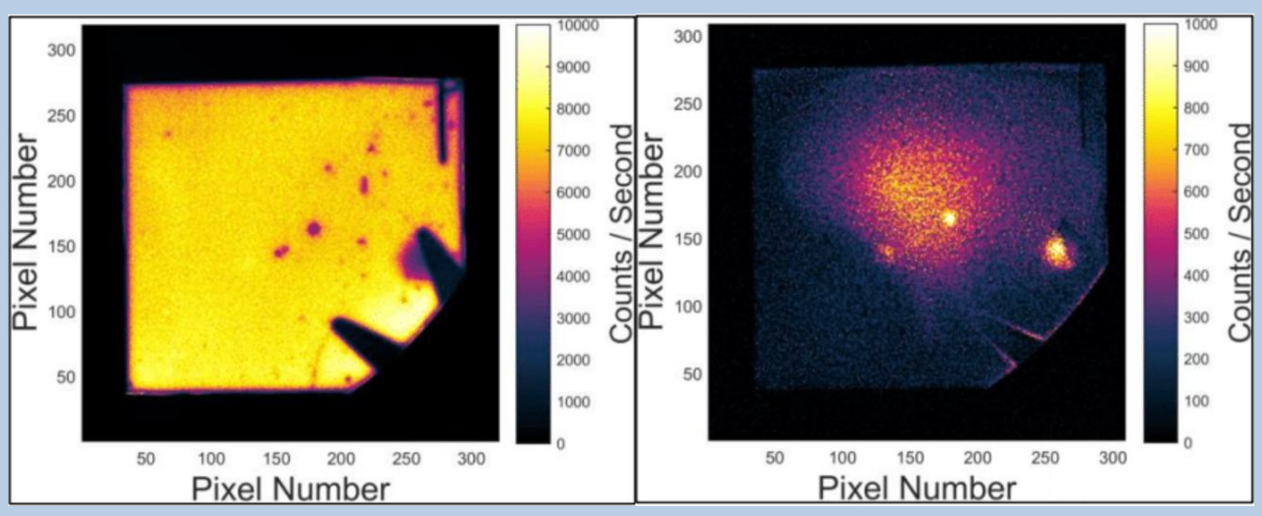


*Fig 6, Photoluminescence imaging after 30 s*

- Visual inspection shows surface structure damage and deformities, with formation of spots and veins

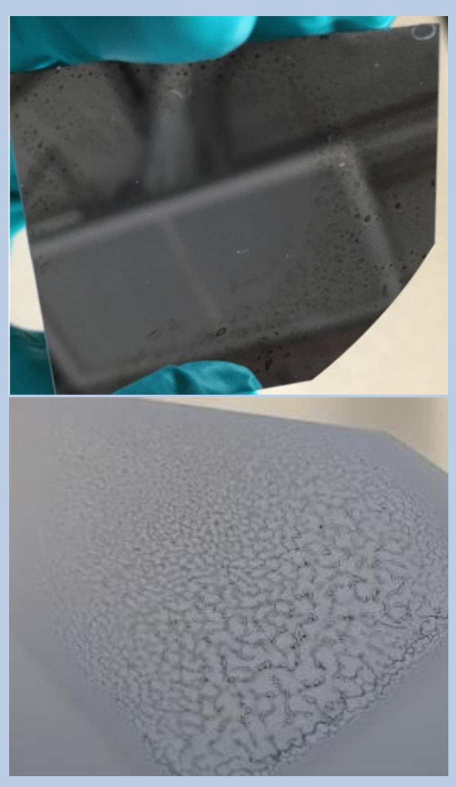

*Fig 7, Surface images of 'corrosion'*

## External Control System

- ❖ Control display features chamber pressure and timer for feedback
- ❖ Pre-set 'Cooking' modes minimises experiment set-up complexity
- ❖ High pressure mode adds up to 80 kPa for stress testing

*Fig 1. Pressure Cooker as an Environmental Chamber*

## Internal Control System

- ❖ Features polycarbonate disks to restrict evaporation, controlling humidity in chamber
- ❖ Sensors allow for logging of internal condition

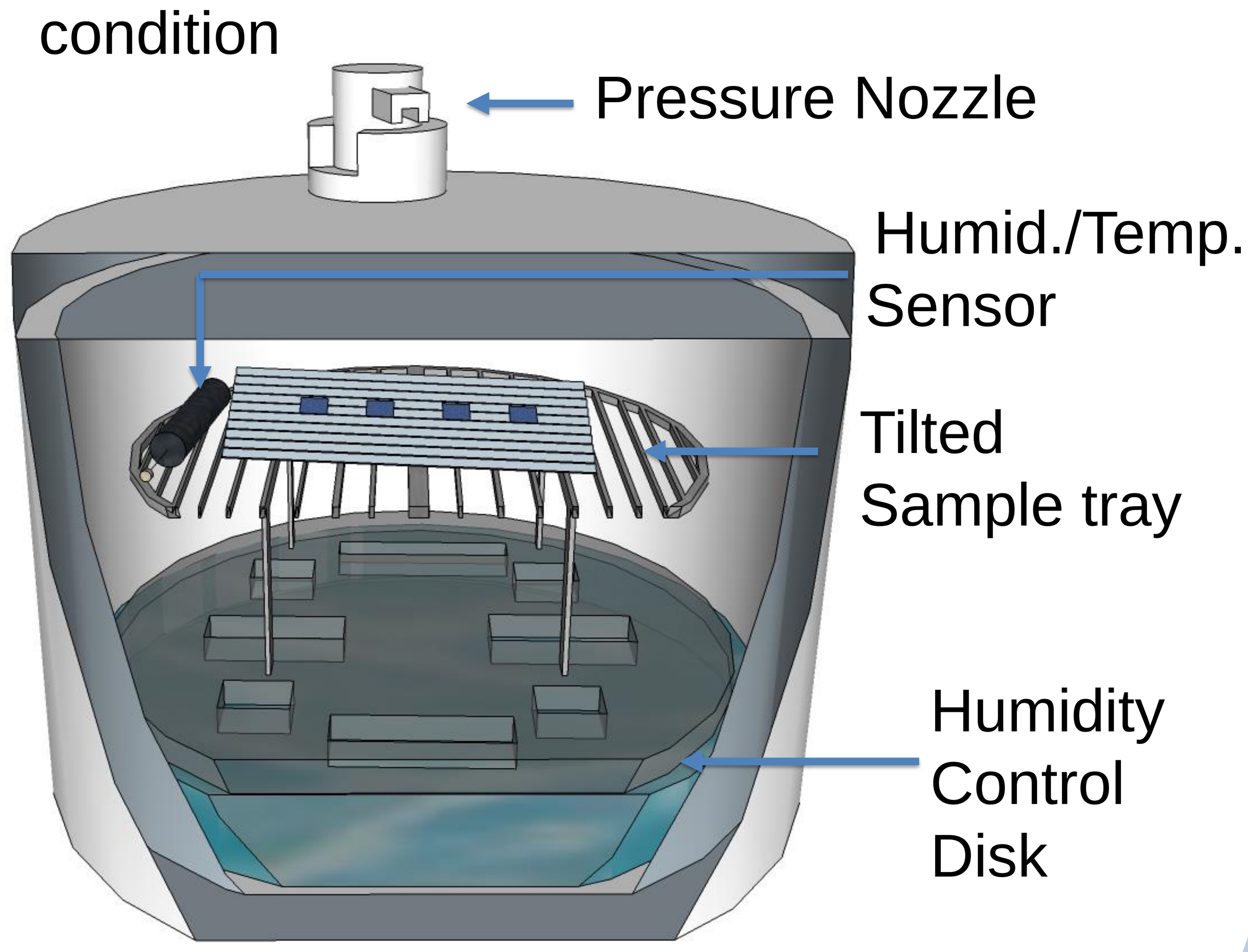


*Fig 2. Repurposed Food Chamber*

## Challenges faced

- ❖ Environmental chamber lacks capability to execute advanced stability tests, such as temperature sweep and low temperature condition
- ❖ Accurate measurement of temperature and humidity is difficult to acquire without use of costly metrology equipment
- ❖ Not suitable for cells that are more durable (eg. $SiN_X$), as maximum running duration is 12 hr

## Conclusion

- ❖ Environmental chamber is suitable for conducting tests under specific conditions
- ❖ $MoO_x$ is more sensitive to humidity than temperature