FABRICATION OF TEMPERATURE MONITORING SYSTEM FOR ART CONSERVATION

UMBC

Alex Holtschneider, Amulya Shrestha, Jacob Bass, Minhquan Tran
Gymama Slaughter, Ankit Baingane, MD Qumural Hassan

University of Maryland, Baltimore County, Baltimore, MD

THE ART WALTERS MUSEUM

Introduction

- Currently, monitoring an artwork's temperature requires obtrusive, expensive equipment.
- Being able to produce low cost temperature monitoring systems is imperative for preserving art in all tiers of museums [1].
- Resistance temperature detectors (RTDs) have a linear resistance-temperature relationship [2].
- **Aim:** Create a RTD-based system that can wirelessly monitor artwork's temperature.

Objective

- Design and fabricate a resistance temperature detector (RTD) with a standardized reference resistance.

Materials

- AZ400K
- HMDS
- AZP4110
- Buffer Oxide Etchant (BOE)
- Deionized Water
- Acetone
- Cr_7^+
- $FeCl_3$
- Glass or Silicon Substrate

Procedures

1. Spin coat a layer of HMDS onto wafer.
2. Spin coat a layer of AZP4110 onto wafer.
3. Apply UV light to react photoresist with light.
4. Develop photoresist into photomask pattern.
5. Etch away excess nickel and excess chromium.

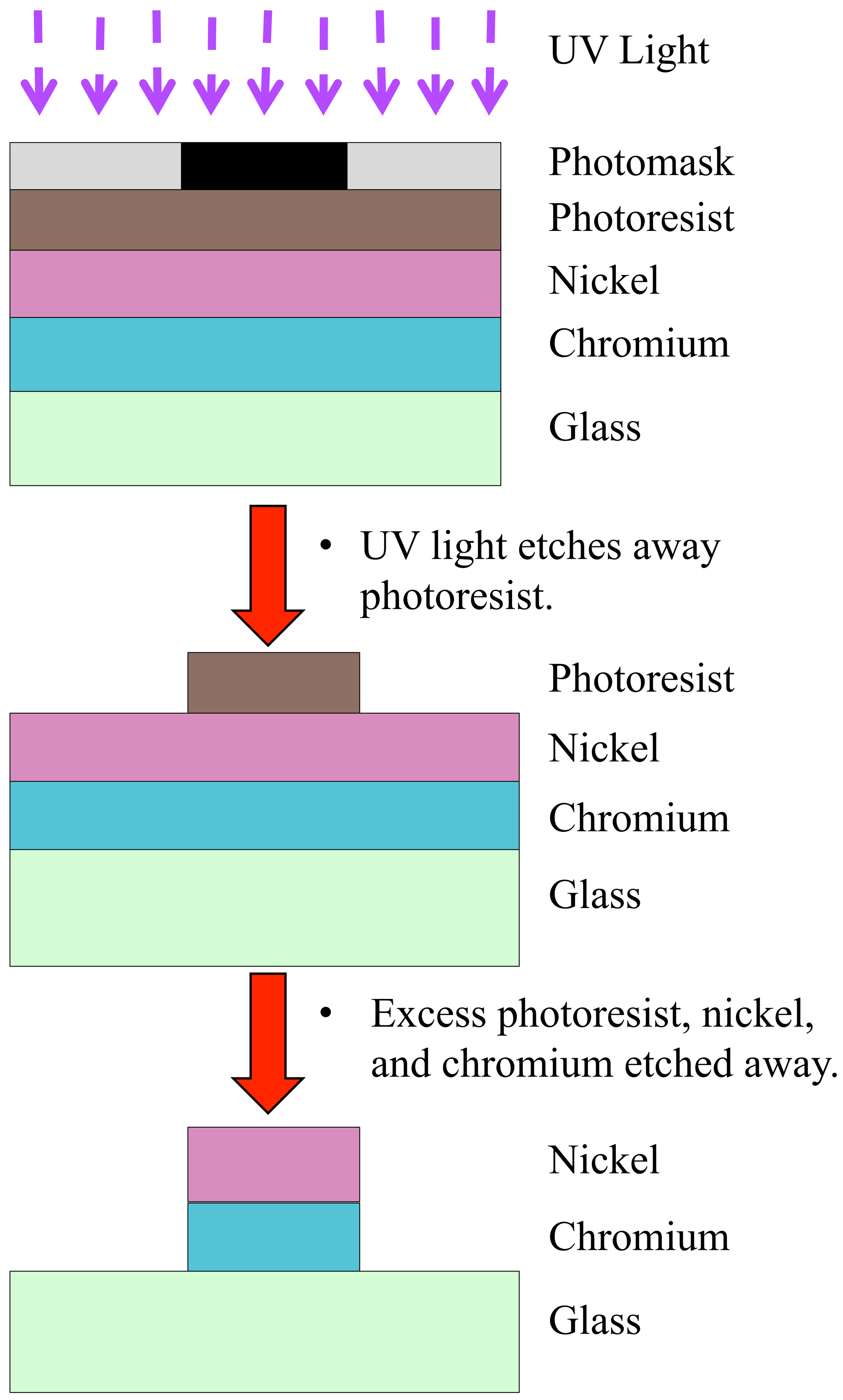
References

[1] https://www.si.edu/mci/downloads/reports/Mecklenburg-Part2-Temp.pdf

[2] http://www.smartsensors.com/specrtds.pdf

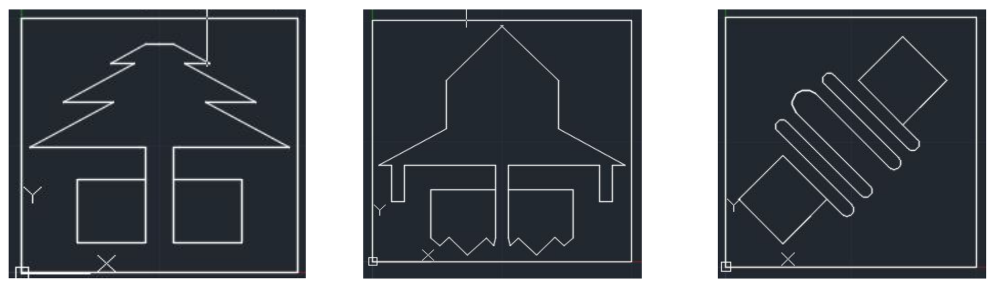
Photolithography

- Process of exposing photoresist to UV light to etch patterns onto a substrate.
- Used to fabricate RTD and signal conditioning circuit.



Design

- **Parameters:**
  - Wire thickness = 200 nm.
  - Minimum line width = 200 µm.
  - Spacing between wires = 200 µm.
  - Minimum pad size = 25×25 mm = 625 mm^2.
- **Calculating Wire Length:**
  - R = Reference Resistance = 100 Ω at 20 °C.
  - ρ = Resistivity = 1.2 × 10^{-7} Ω•m.
  - A = Cross-sectional area of wire.
    = thickness × width = 40 μm^2.
  - $R = \frac{\rho L}{A} \longrightarrow 100 = \frac{(1.2\times10^{-7})L}{40\times10^{-12}} \longrightarrow L = 3.\overline{33}$ cm.
- **Sample Designs:**

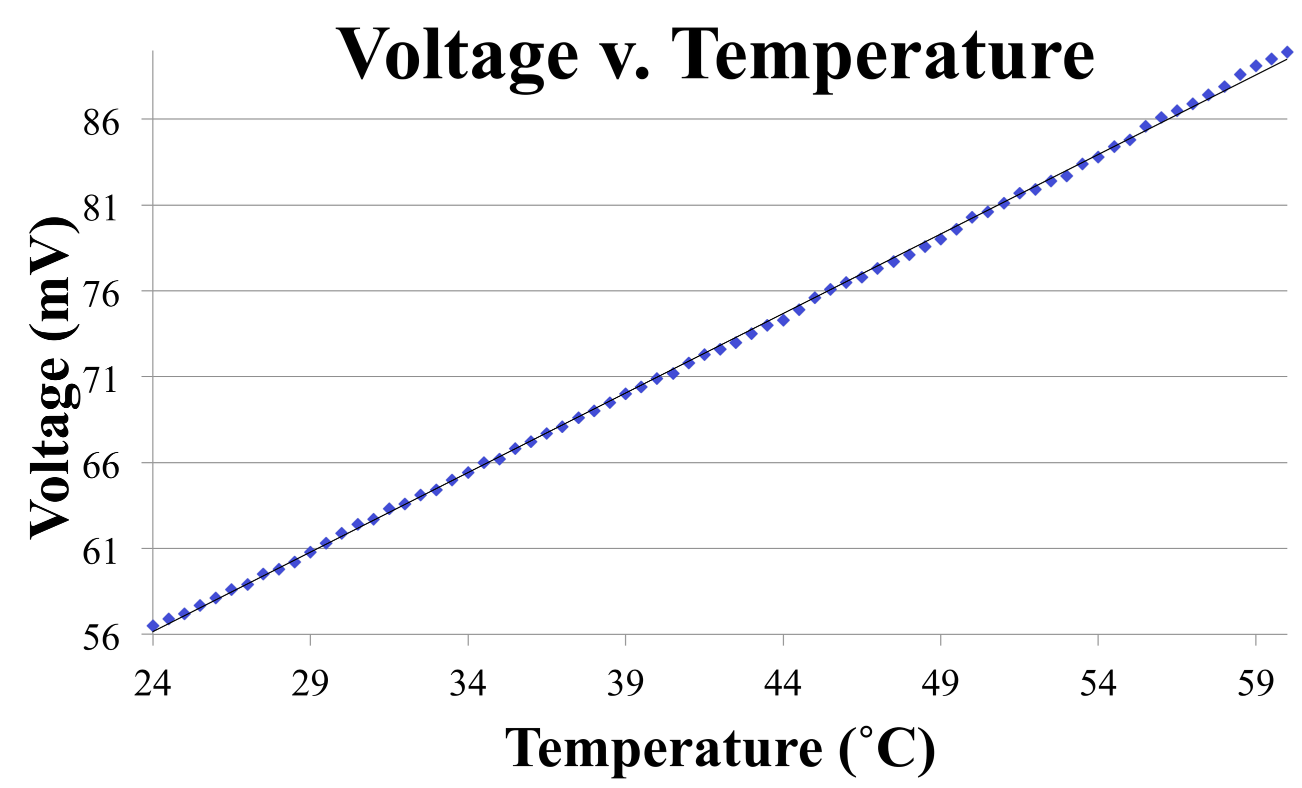


Characterization

- Given the linearity of the temperature-resistance relationship with RTDs, it is possible to characterize a linear equation relating them.

- **Water Bath Testing:**
  - Coated RTD with liquid electrical tape, allowing submersion into water.
  - Measured voltage across RTD in 0.5°C increments.
  - Can determine resistance given voltage and constant current source.

- **Results:**
  - $V = 0.9263T + 33.926$
    - V = Voltage (mV)
    - T = Temperature (˚C)
  - $R^2 = 0.9996$
    - Extremely linear relationship



Next Steps

- **Short Term:**
  - Characterize newly fabricated RTDs with reference resistance of 100 Ω.
  - Utilize a more precise temperature control system and temperature monitoring system.
- **Long Term:**
  - Integrate a RTD and other sensor into system that can measure an artwork's environment temperature and wirelessly transmit data to a central hub.

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