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Magnetron Metal Deposition
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Abstract
The purpose of this research is to explore magnetron metal deposition (MDD) and its effectiveness in coating glass with conductive material. A particular interest in this research is the rate at which the conductive material is deposited on the glass slide and surface structure of the deposited material. To better understand the principles of MDD a glass slide is placed in a very low pressure environment (approximately $10^4$ Pascals) with a large potential difference applied between two electrodes. One of the electrodes consists of a conductive material foil (lead and nickel) which is then deposited onto the glass slide by way of sputtering.

Sputtering is a physical vapor deposition method where an inert gas is let into the low pressure environment and a high potential difference is applied. The gas ionizes and results in the acceleration of ions into the conductive foil. The ejected material will then deposit onto the slide. The magnetron creates a magnetic field that concentrates the ionized gas in front of the target which results in more collisions between the ions and the foil. It should also result in a more uniform layer of deposited material.

The results are expected to be a mixture of different factors such as the material being sputtered, the time the system operates, the temperature of the system, the potential difference used and the amount of gas allowed in the chamber.

The significance of this work is that the resultant deposited thin film can be used for further research into optical properties of thin films and superconductors and knowing the rate of deposition will mean that further experimentation can be fine-tuned for future research.

Set-up
- 2 transformers connected in parallel (output of 60mA and 15,000V)
- Vacuum chamber
- Argon Gas
- Pump
- Magnetron Platform
- Magnets

Experiment
Argon gas is slowly let into the vacuum chamber and the system is powered ON to apply a large potential difference across the gas. Lead is sputtered onto a glass slide in increments lengthwise. Each increment will have increased sputtering time with the first increment starting at 20 minutes and increasing 20 minutes each time. This will create a macroscopic view that will look similar to stair steps. To conceptually determine the microscopic structure, the glass slide will need to be looked at under a light. If the light reflects specularly than the surface structure is very smooth. If the light reflects diffusely the surface structure will have sputtered unevenly.

Results and Data
The initial results of the magnetron sputtering are promising. The initial test was run with lead. After a certain threshold, the temperature in the vacuum chamber increased to the point where the lead became too soft and the metal deposited onto the slide unevenly. However when the test was re-run with nickel, a metal less susceptible to softening in high temperatures, the result was a smoother surface but with much less surface thickness.

Analysis
Successes:
- Coating appears to be uniform at low temperatures.
- Less argon is required to collide with the surface of the target material

Problems:
- Long sputtering times cause high temperature and low uniformity
- Sputtering system imperfect and it may allow contamination of sputtering material

Conclusion and Future
The future of this research is in determining the true surface structure using a scanning electron microscope. This should give a clearer picture as to how the sputtered material is being deposited onto the slide. Once the structure has been defined the magnetron sputtering system can be adjusted to gain greater uniformity. Once near perfect uniformity is achieved the system can be used to make a variety of different optical equipment.