Appendix: C

Thin-film/electrode coating by Thermal Metallization Unit

For applying halfwave voltage and coercive fields for forward and reverse poling of the LN crystal, metal (e.g., Al) electrodes are to be deposited on the specific surfaces of the samples. To accomplish this, a thermal metallization/evaporation system is required. The unit (Model No.: BC-300) which is utilized for this purpose, is obtained from HIND-HIVAC Pvt. Ltd. (India), is a very sophisticated thin film coating unit. This unit can be used for depositing very thin (of the order of nanometer) metal electrodes on required substrates. For measuring the thickness of the deposited film, a piezoelectric crystal based thickness monitoring system is provided with the unit. Schematic of the whole unit is illustrated in Figure C.1.

For depositing the required thin-films/electrodes on the specific surfaces of the LN samples, some successive steps are to be followed which are described in the following.

1. At first the cleaned samples covered with proper mask are positioned on the ‘Substrate Holder’ inside the ‘Deposition Chamber’. Then the coating material (in this case Al) is placed over the (LT) heating coil inside the chamber. Finally the airtight door of the chamber is closed.

2. Then the AC Main of the unit is switched ON.

3. Then the rotary pump attached with the unit is turned ON and the ‘Foreline Valve’ is placed at the OPEN position. After 20-25 minutes the pressure of the ‘Diffusion Chamber’ falls nearly to $10^{-3}$ mbar, measured by a Pirani gauge, and then the ‘Foreline Valve’ is placed at the CLOSE position.

4. Next the ‘Roughing Valve’ is placed at the OPEN position. The rotary pump, pumps out the air from the chamber and creates vacuum of the order of $10^{-3}$ mbar after 20-25 minutes. The valve is then placed at the CLOSE position.

5. Now the ‘Foreline Valve’ is again placed at the OPEN position and the attached ‘Chiller’ is switched ON. During that the ‘Diffusion Pump’ is also turned ON. After approximately 30 minutes the ‘Diffusion Chamber’ pressure falls to nearly $10^{-3}$ mbar. At this time the ‘Gate
Valve’ is kept at OPEN position so that the ‘Deposition Chamber’ and ‘Diffusion Chamber’ are directly connected to each other.

The limitation of the rotary pump is that it cannot create a vacuum of lower order than $10^{-3}$ mbar. In order to generate a very high vacuum of the order of $10^{-6}$ mbar the ‘Diffusion Pump’ is employed. As it uses mercury vapor jet chilled water circulation is must for its normal operation. After 2-3 hours of opening the ‘Gate Valve’ the pressure of the ‘Deposition Chamber’ is measured by a Penning guage, which should be $10^{-5} - 10^{-6}$ mbar.

6. When the vacuum of the desired order is created in the chamber the HT control switch is turned ON and voltage between the discharge plates, situated inside the ‘Deposition Chamber’, is controlled so that arc discharge occurs which can strike out the gas molecules attached with the substrate through intermolecular force.

![Figure C.1: Schematic of thermal metallization unit](image)

7. Next the LT circuit is switched ON to heat up the filament in the ‘Deposition Chamber’. The coating material attached to it melts and due to surface tension the melted material gets stuck to the filament. When more voltage is applied across the filament the metal molecules start evaporating isotropically and thus results in coating of the chamber and the substrate. Hence the coating material is deposited on the substrate and coating procedure is completed.
8. After the completion of the coating process the ‘Gate Valve’ is kept in the CLOSE position. So the ‘Deposition Chamber’ is isolated from the ‘Diffusion Pump’. Thus at this stage it is safe to switch off the said pump. The system is then kept in this state for next half an hour. Finally the ‘Foreline Valve’ is closed and the AC mains of the unit and chiller are switched OFF.