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A triple source ionized cluster beam deposition system was purchased and installed as part of a thin film research facility. A scanning auger system was added with ISU matching funds.

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Final Report

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MATTHEW J. KERPER
Chief, Technical Information Division

The 1984 DoD University Research Instrumentation Program Grant to ISU was for Phase II of construction of a major thin film research facility. The grant was to provide for a three source ultrahigh vacuum (UHV) ionized cluster beam (ICB) deposition system to be connected to the UHV transfer system constructed in Phase I. Cost sharing on the grant by ISU provided for a scanning Auger system.

The overall plan for the facility is shown in Figure 1. The sputtering system was constructed previously as part of a research program on deposition of AlN thin films supported by AFOSR. It is currently being used to deposit high purity oriented AlN films on silicon substrates. The electron energy loss spectrometer (EELS) with LEED and UPS was constructed with partial support from DoE and ISU funds. The EELS is being used to study surface phonons on single crystal and amorphous silicon. These measurements are supported by theoretical first-principle calculations of silicon surface phonons by a local theorist Dr. Kai-Ming Ho.

The single source ICB is being used for epitaxial film studies. A number of oriented films of aluminum have been grown on silicon substrates. The films show no oxygen or carbon impurities but have some interaction with the silicon at the interface. Films of epitaxial (100) germanium are now being grown on (100) silicon at 400°C with sharp interfaces. No carbon crucible contamination is found.

The three source ICB system constructed with this grant has a locally designed vacuum chamber with a base pressure of $< 5 \times 10^{-10}$ Torr. In addition to three ports for ICB sources, the base plate also has ports for conventional style MBE effusion cells to increase the flexibility of the system for compound deposition. The chamber has ports for RHEED and ellipsometry. Three second generation sources and power supplies were purchased from Eaton Corporation. As modified for our systems, these sources have been repeatedly heated to ~1700°C with little difficulty. This is in contrast to the initial source for the single source system which had to be rebuilt after each run.

The three sources, with all support leads, are built on individual 8 inch OD flanges for rapid removal for servicing. Each also has a port for crucible introduction. These sources are water cooled to reduce heating of the chamber and undesirable outgasing.

The three power supplies were damaged in shipment and have required extensive repair before use. The three supplies and associated controls are totally independent so that each can be operated separately or from a single control.

A scanning Auger based on the Perkin Elmer 545 system has been constructed. It incorporates a Kratos rastorable ion gun for depth profiling. Lateral resolution for imaging and Auger mapping is about 1 μm. A depth profile of an AlN film is shown in Figure 2.

The Auger chamber makes use of differential pumping of the ion gun and a load-lock to maintain a low pressure at all times in the analysis chamber. A base pressure of $< 2 \times 10^{-10}$ Torr. is routine.

As the lowest possible base pressures are required in all the systems, efforts have been concentrated on getting each system operational with its own load-lock. This allows independent operation during initial test periods when the vacuum systems must be repeatedly cycled to atmospheric pressure. Each system is integrated with the transfer line once it is fully operational.

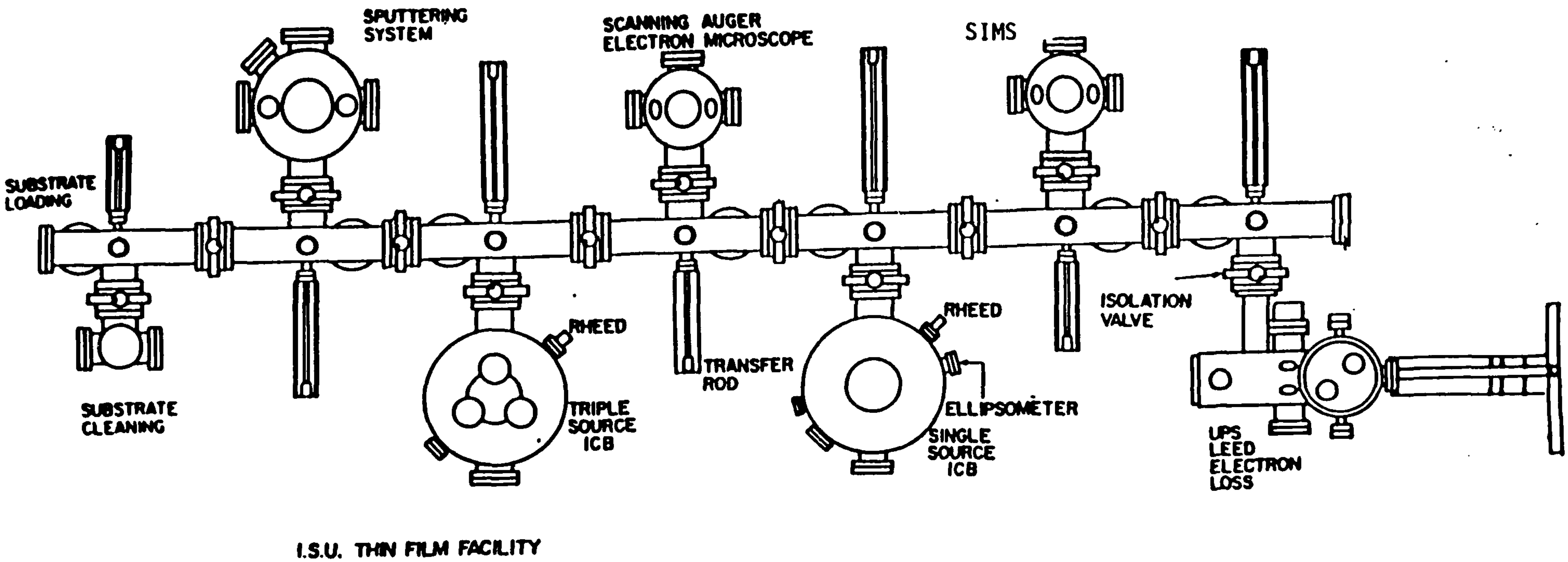

Figure 1. ISU Thin Film Facility. This grant provided for the purchase of the three source ICB system and the scanning Auger system.

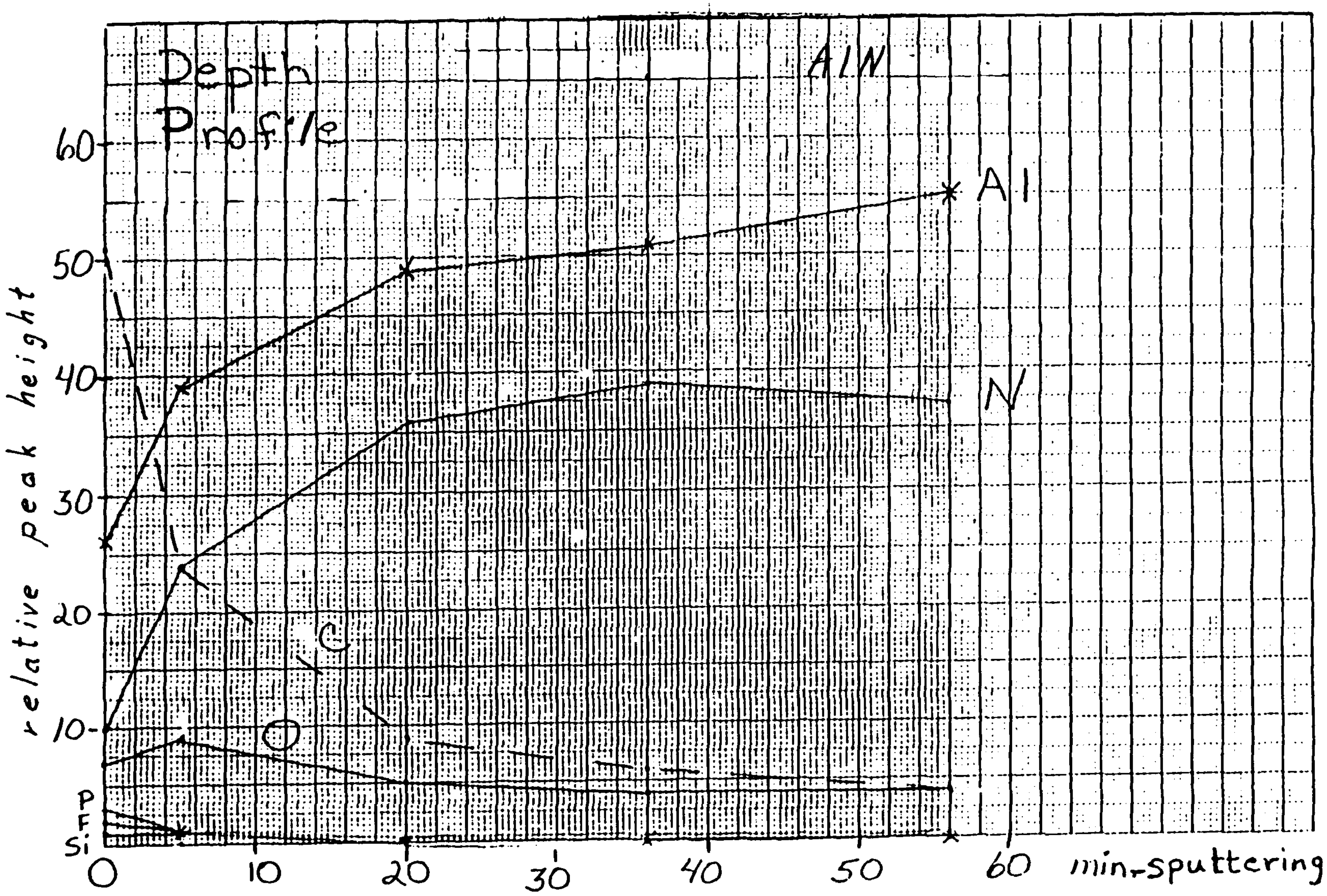

Figure 2. Auger depth profile of AlN sample.