
Ozone/TEOS CVD Oxide Deposition using DLI

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OBJECTIVES

- Conduct Experiments in the LPCVD to APCVD in broad Temperature and Flow range
- Optimize the Ozone/TEOS Process for high quality films with excellent Step Coverage, high Deposition Rates and good Uniformity
- Model the Deposition Rate behavior capturing underlying mechanisms to predict experimental results - with precisely known inlet conditions
- Step Coverage experiments on shallow and deep trenches as a function of Deposition Temperature, Pressure and Ozone/TEOS ratio

ACCOMPLISHMENTS SUMMARY

- A Research reactor built at IBM, Yorktown to conduct experiments in the LPCVD to APCVD range (30-760 torr)
- Experimental Results compare well with the Modeling Predictions

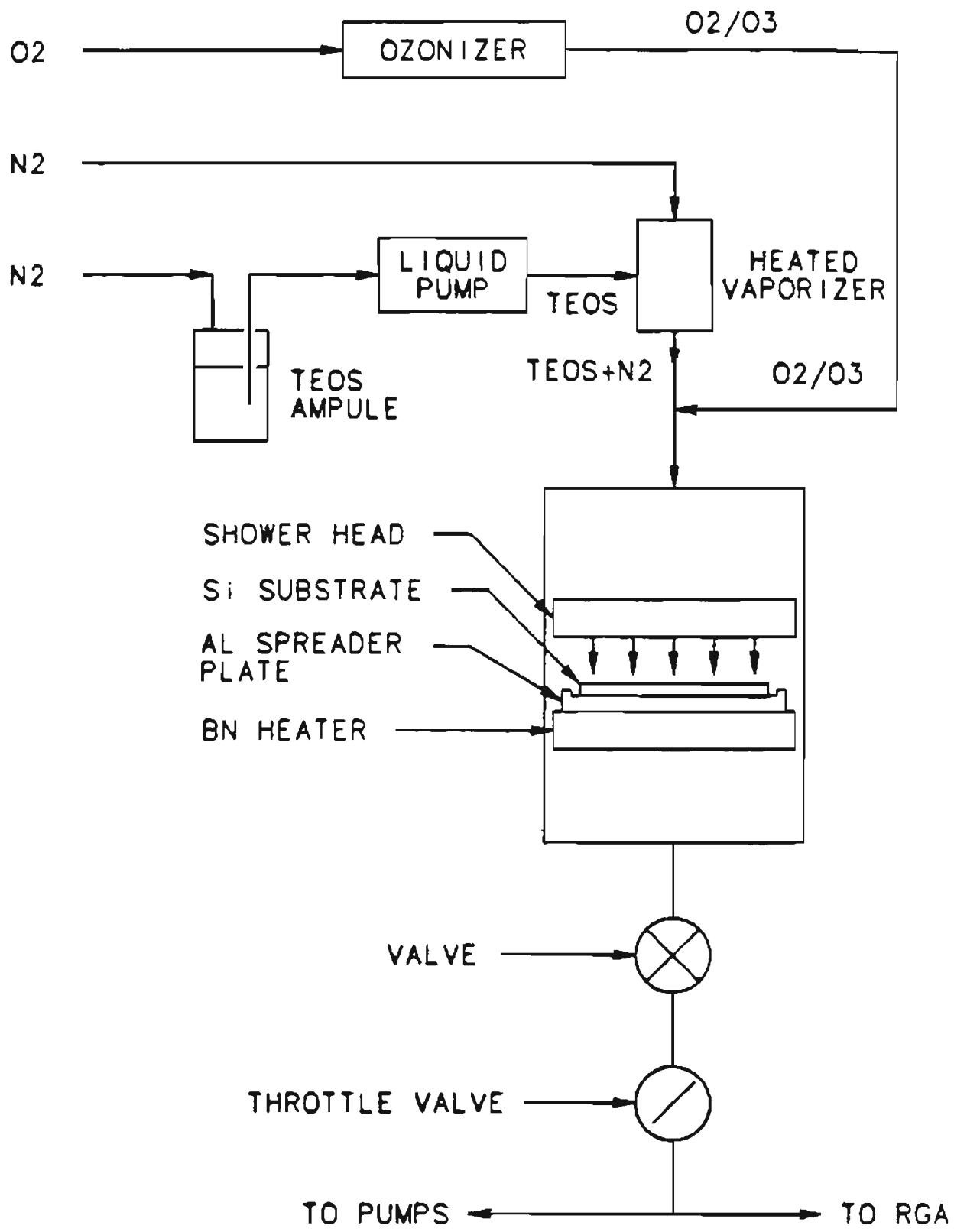


FIG 1 SCHEMATIC DIAGRAM OF O₃/TEOS REACTOR

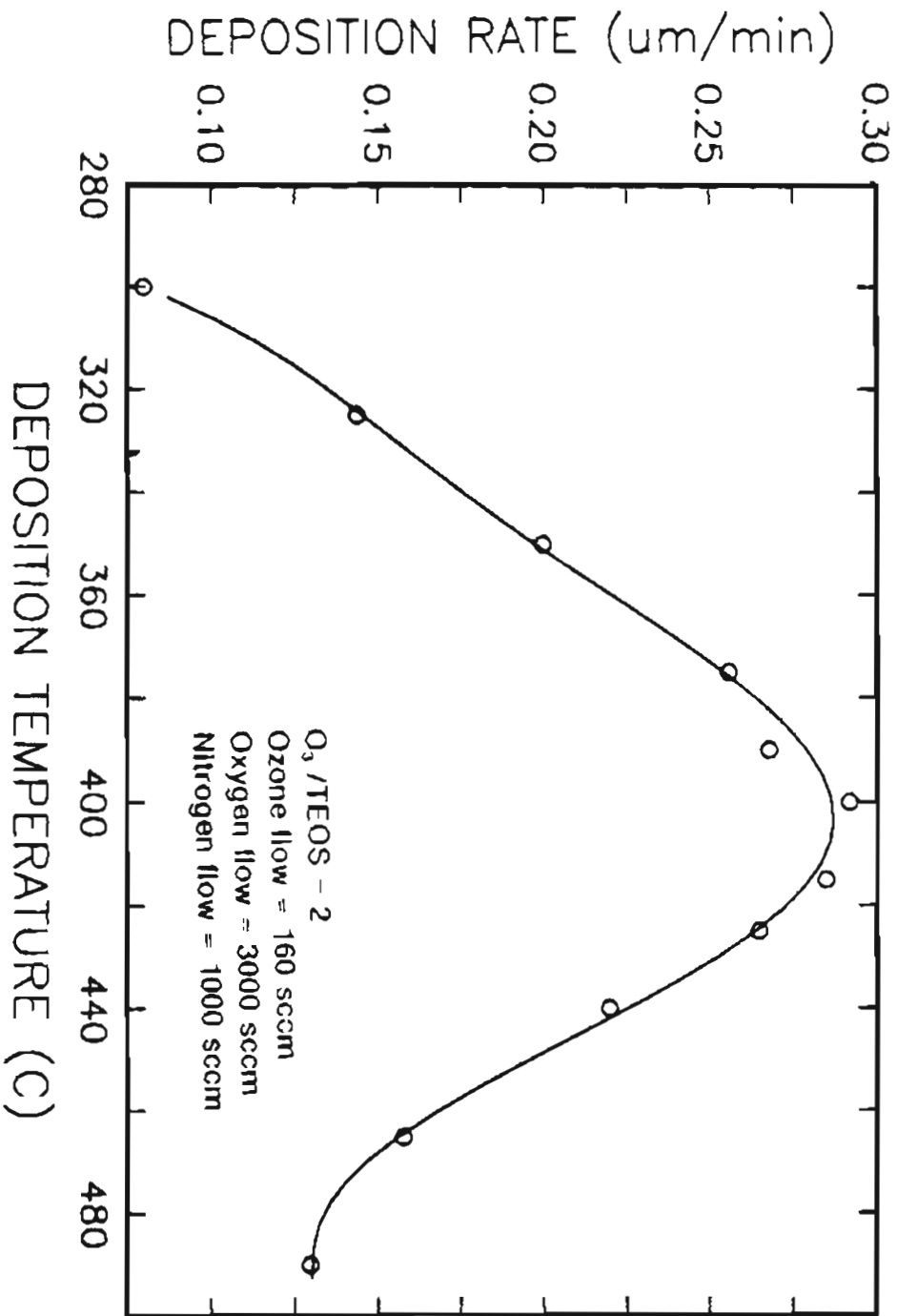


Fig. 2 Deposition Rate as a function of Deposition Temp at 30 Torr

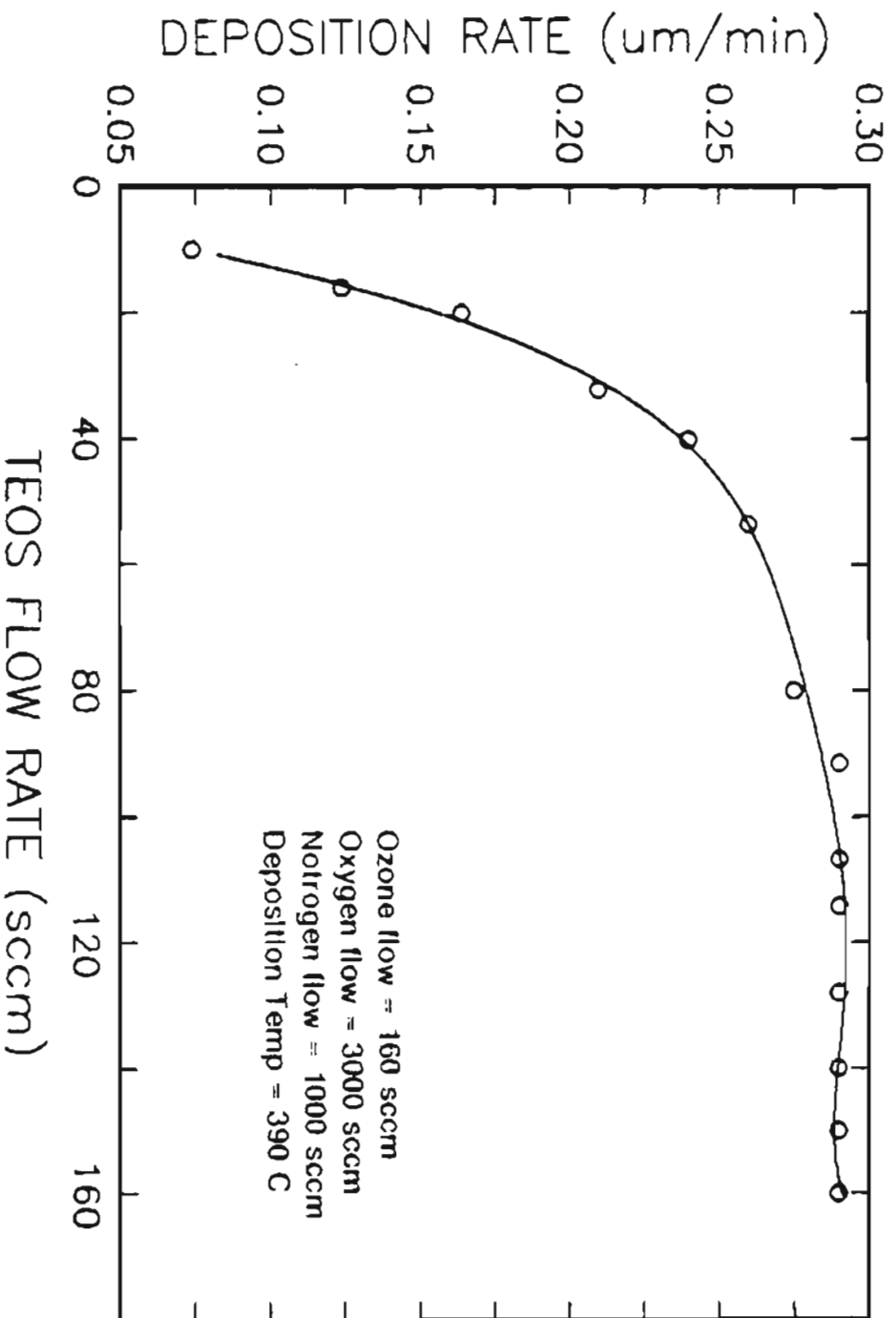


Fig. 3 Effect of TEOS flow rate on Deposition Rate at 30 Torr -390C

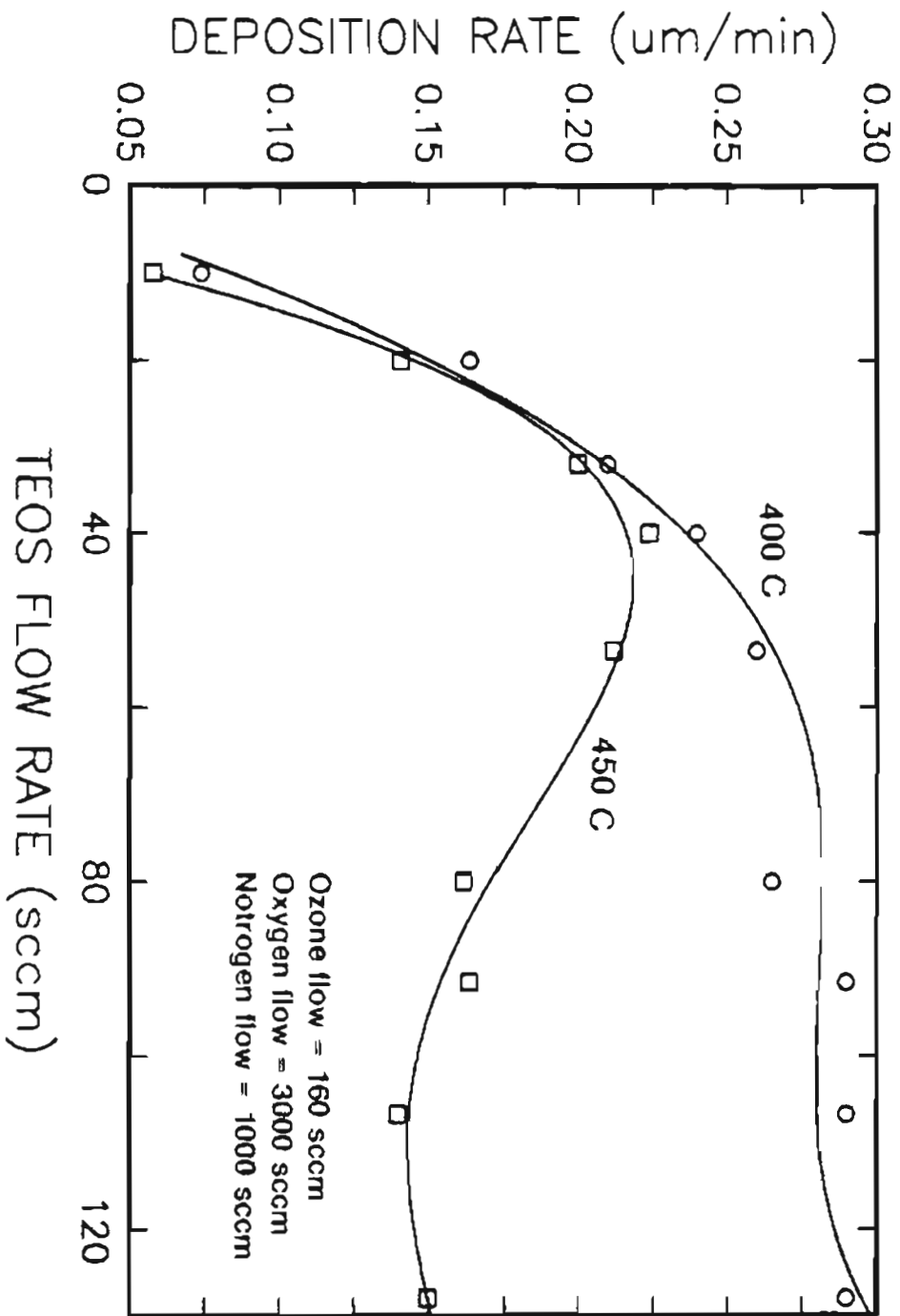


Fig. 4 Comparison of Dep. Rates at 390 C and 450 C - 30 Torr

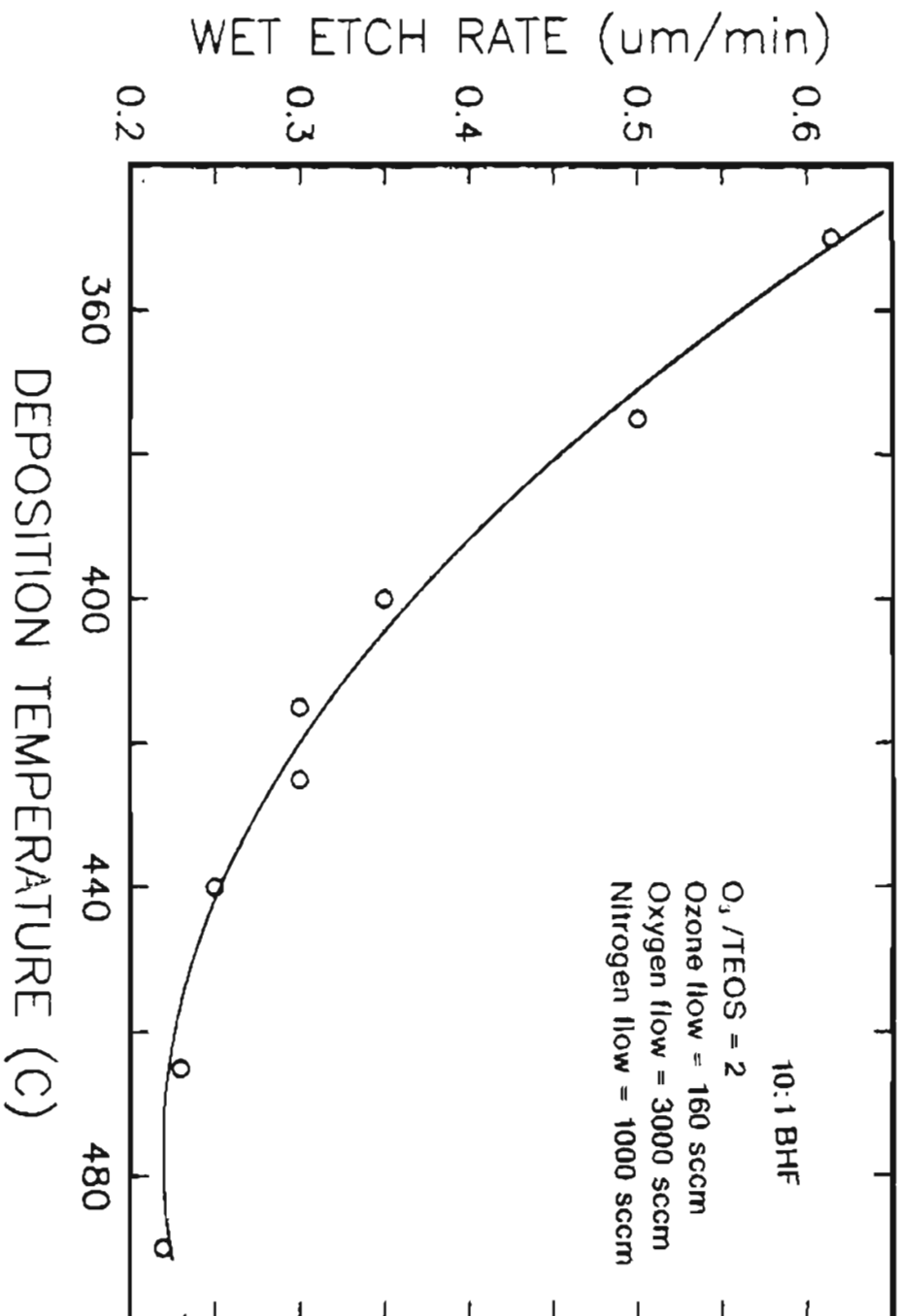


Fig. 5 Wet Etch Rate as a function of Temp. at 30 Torr

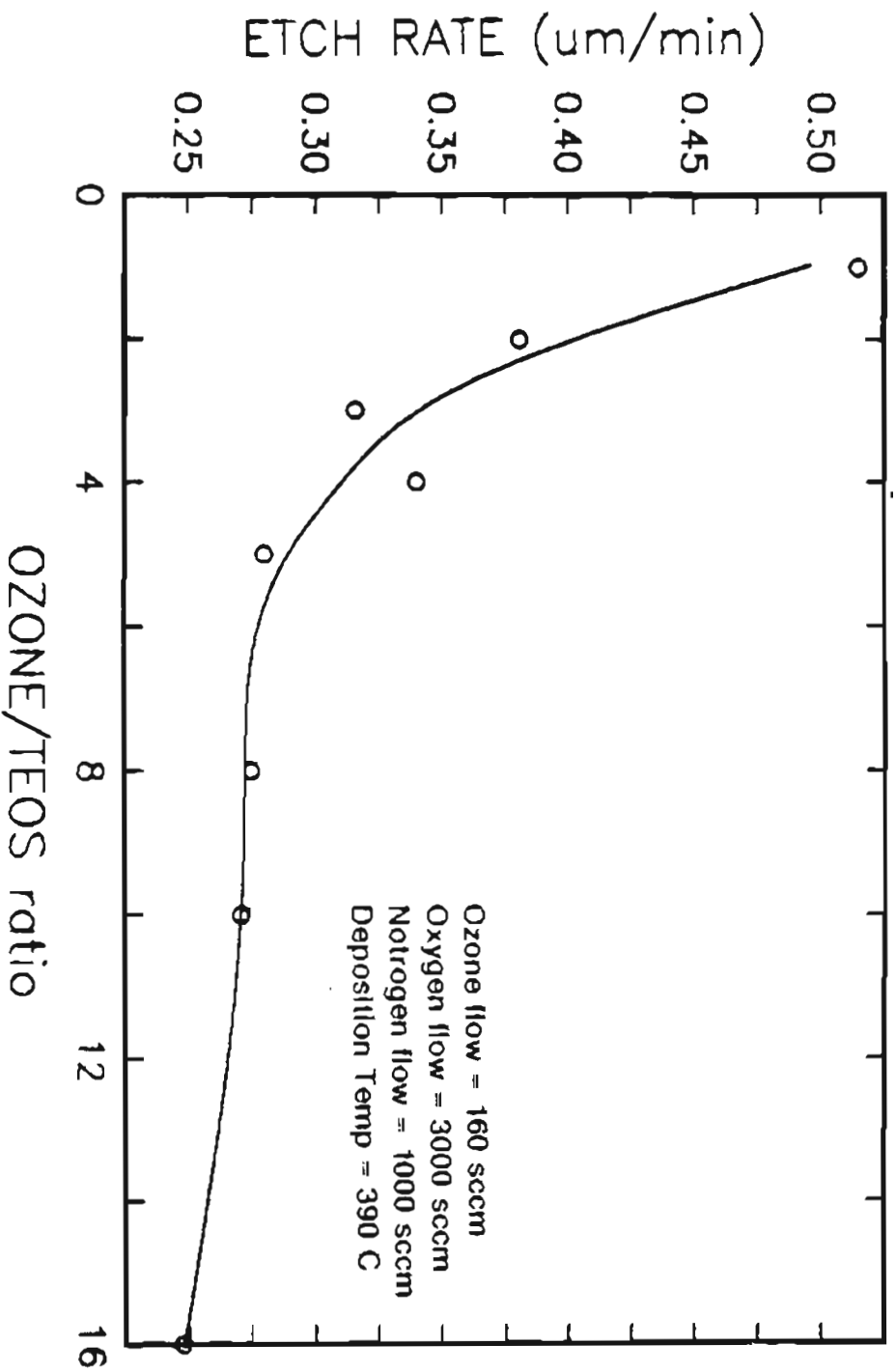


Fig. 6 Etch Rate Variation with Ozone/TEOS ratio - 30 Torr



Fig. 7. 30 Torr, F-teos=80 sccm, F-O3=160 sccm, F-O2=3000 sccm, F-N2=10.0 sccm, T=415 C

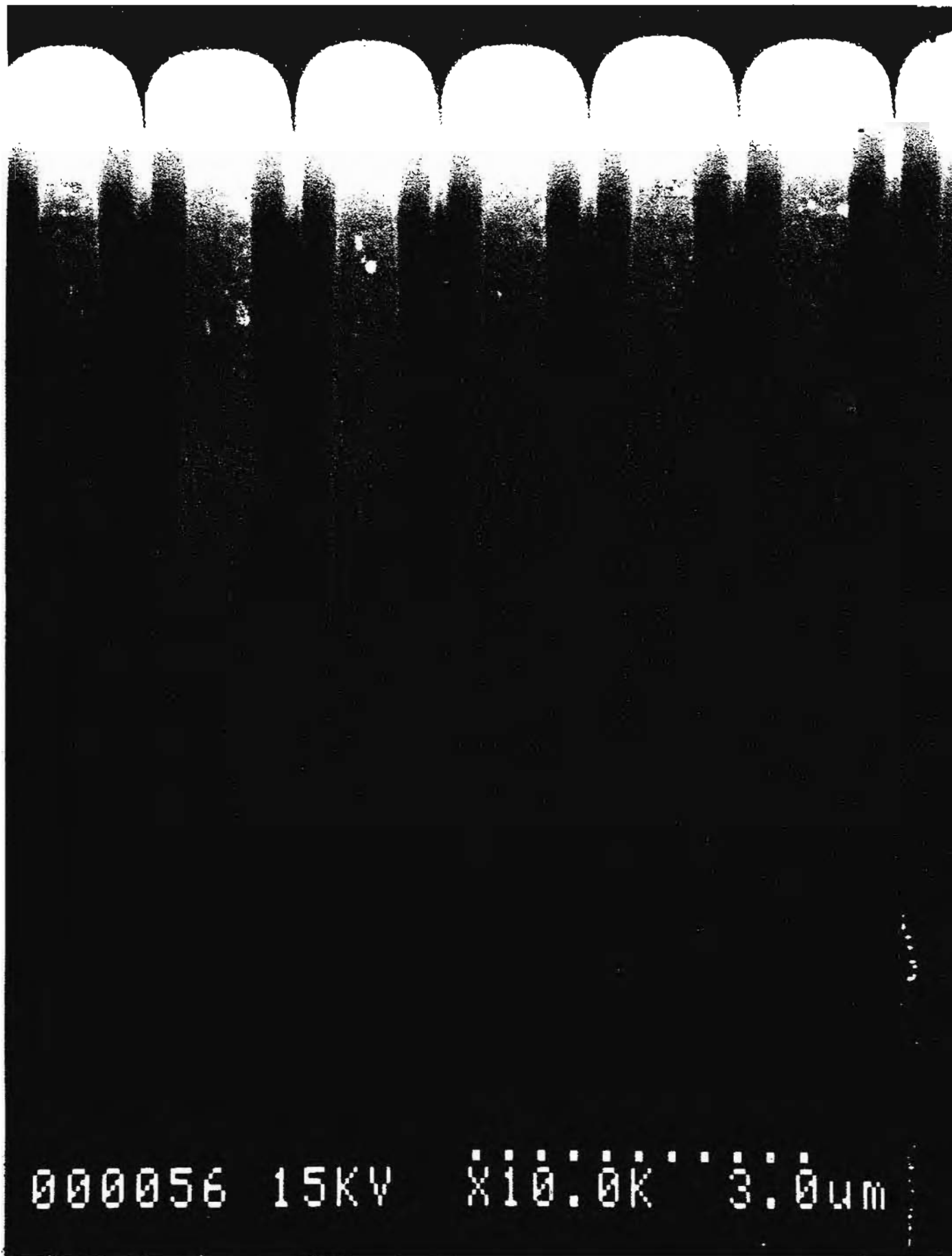


Fig. 8. 30 Torr, F-teos=80 sccm, F-O3=160 sccm, F-O2=3000 sccm, F-N2=1000 sccm, T=465 C



Fig. 9. 30 Torr, F-teos=80 sccm, F-O3=160 sccm, F-O2=3000 sccm, F-N2=1000 sccm, T=490 C

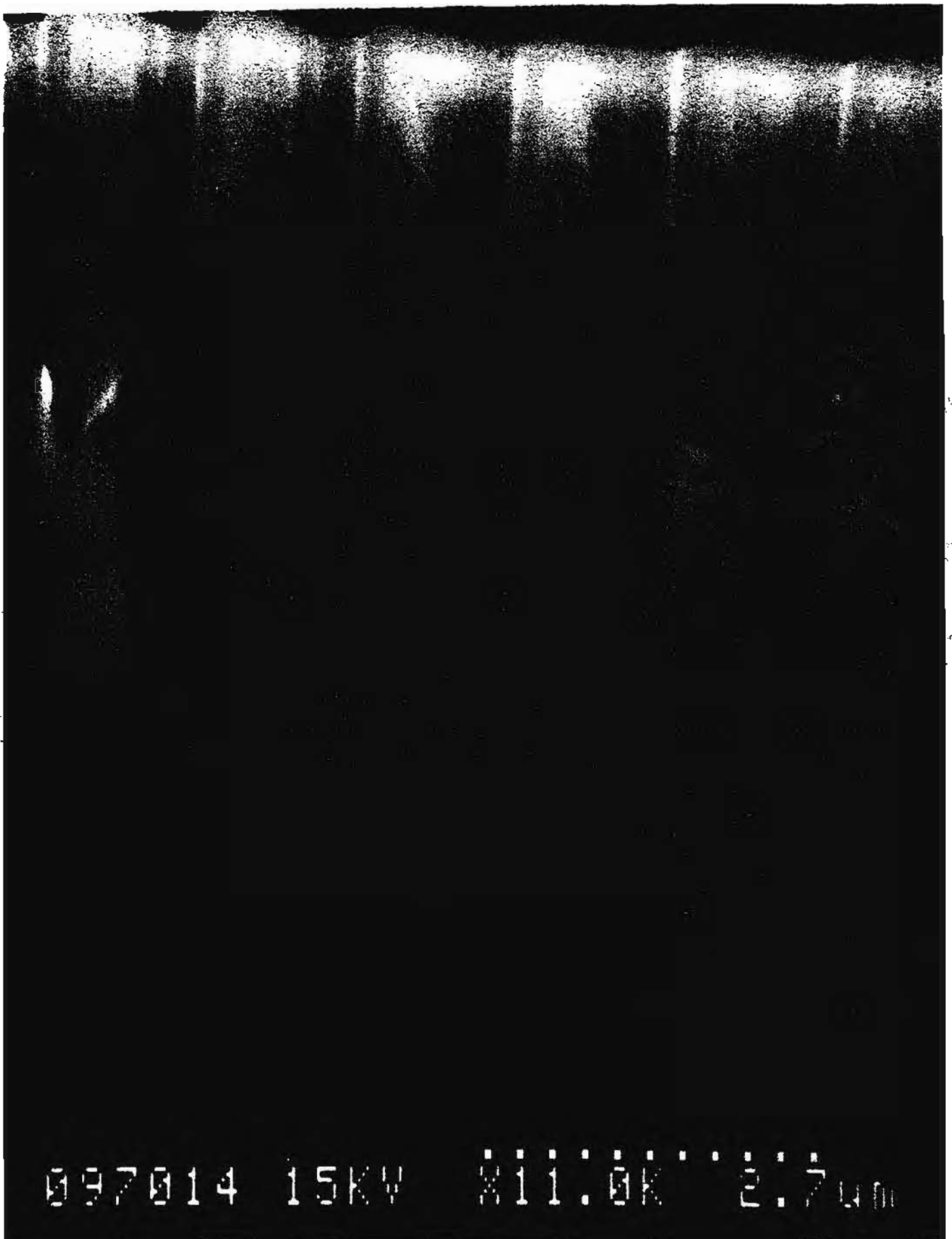


Fig. 10. 30 Torr, F-teos=20 sccm, F-O3=160 sccm,
F-O2=3000 sccm, F-N2=1000 sccm, T=390 C

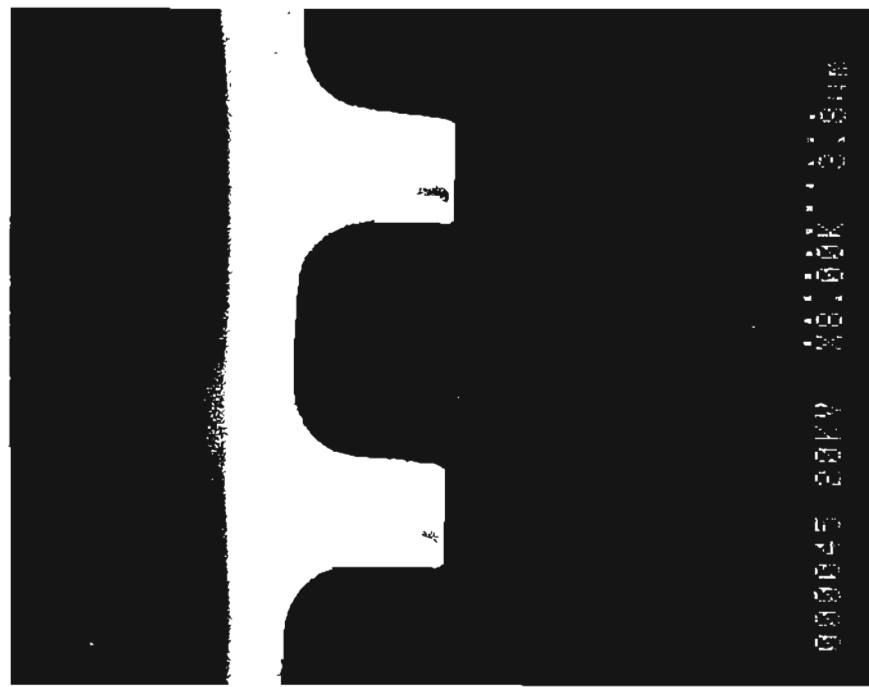
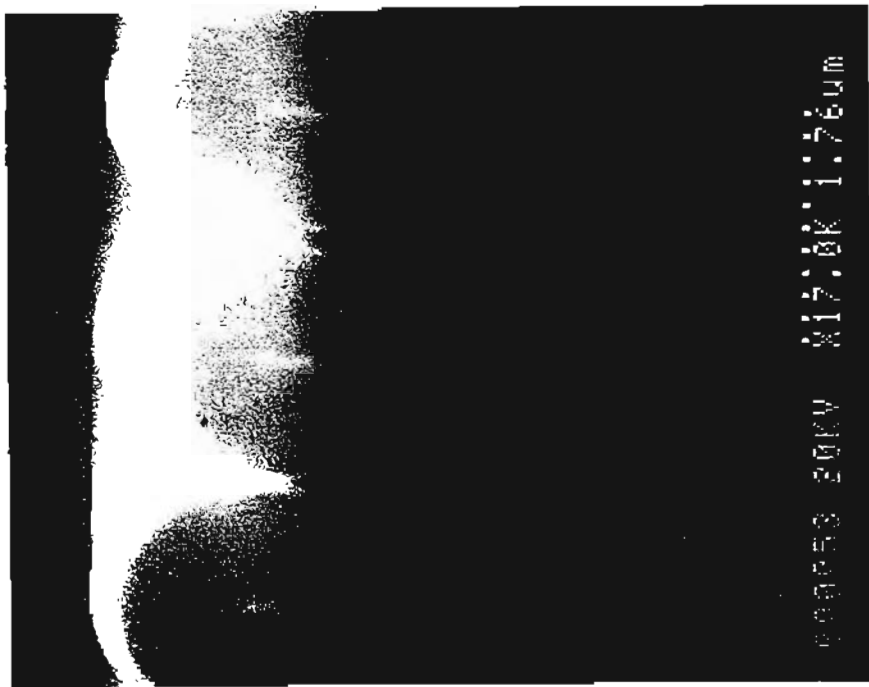


Fig. 11. 200 Torr, F-teos=65 sccm, F-O3=325 sccm,
F-O2=10 slm, F-N2=20 slm, T=370 C

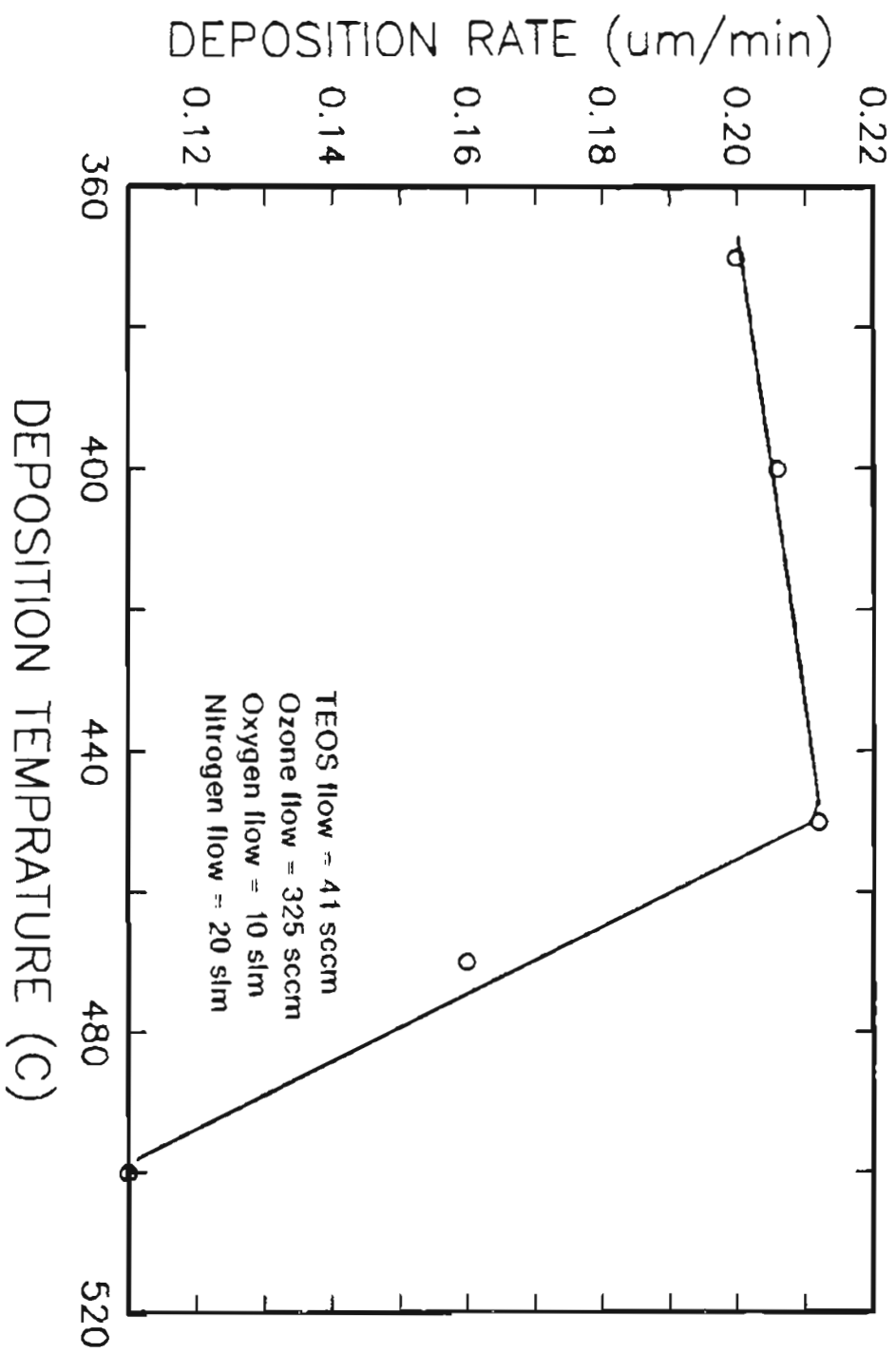


Fig. 12 Effect of Deposition Temp. on Deposition Rate at 200 Torr

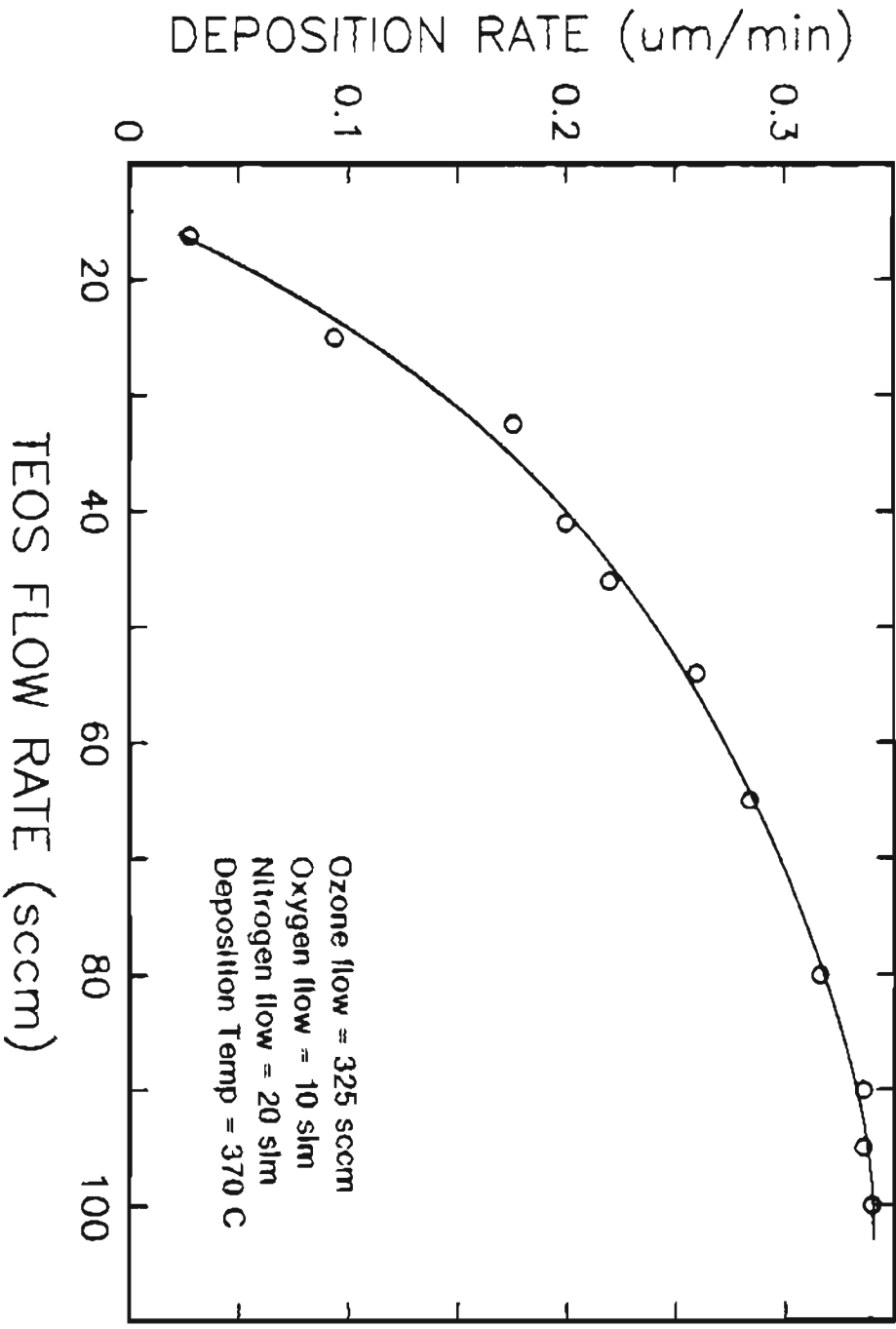


Fig. 13 Effect of TEOS flow rate on Deposition rate at 200 Torr

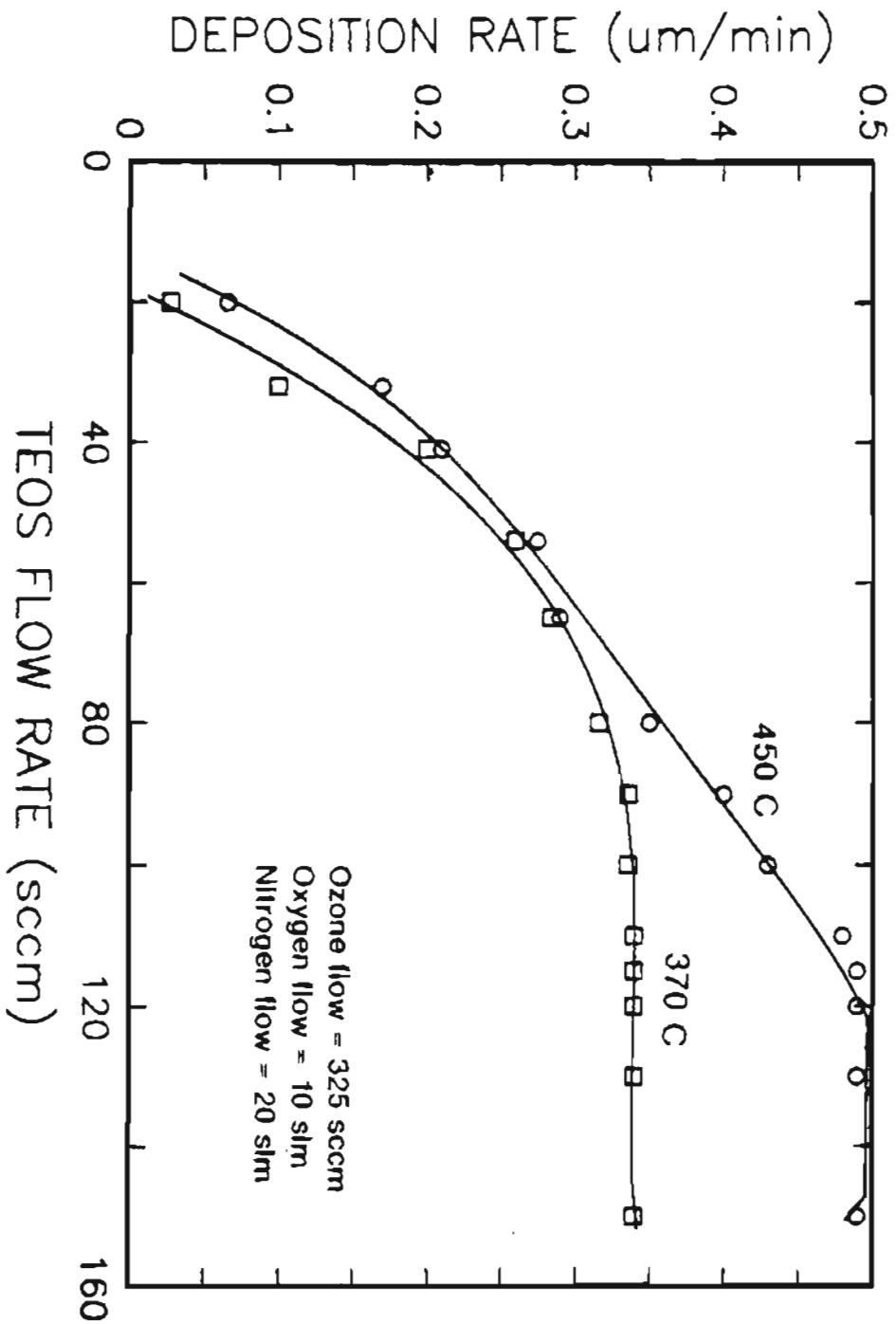


Fig. 14 Comparison of Deposition Rate at 370 C and 450 C - 200 Torr

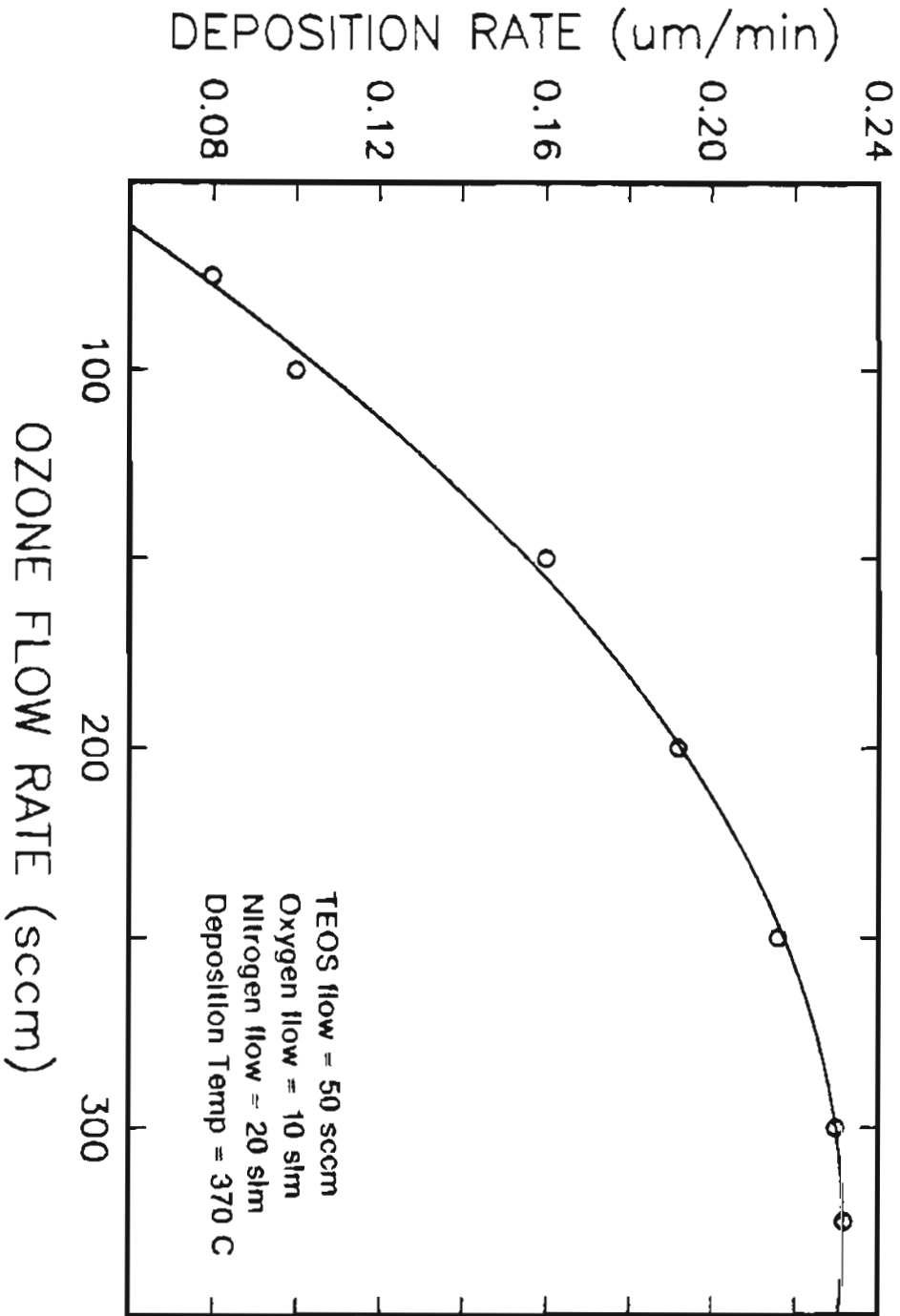


Fig. 15 Deposition Rate as a function of Ozone Flow at 200 Torr

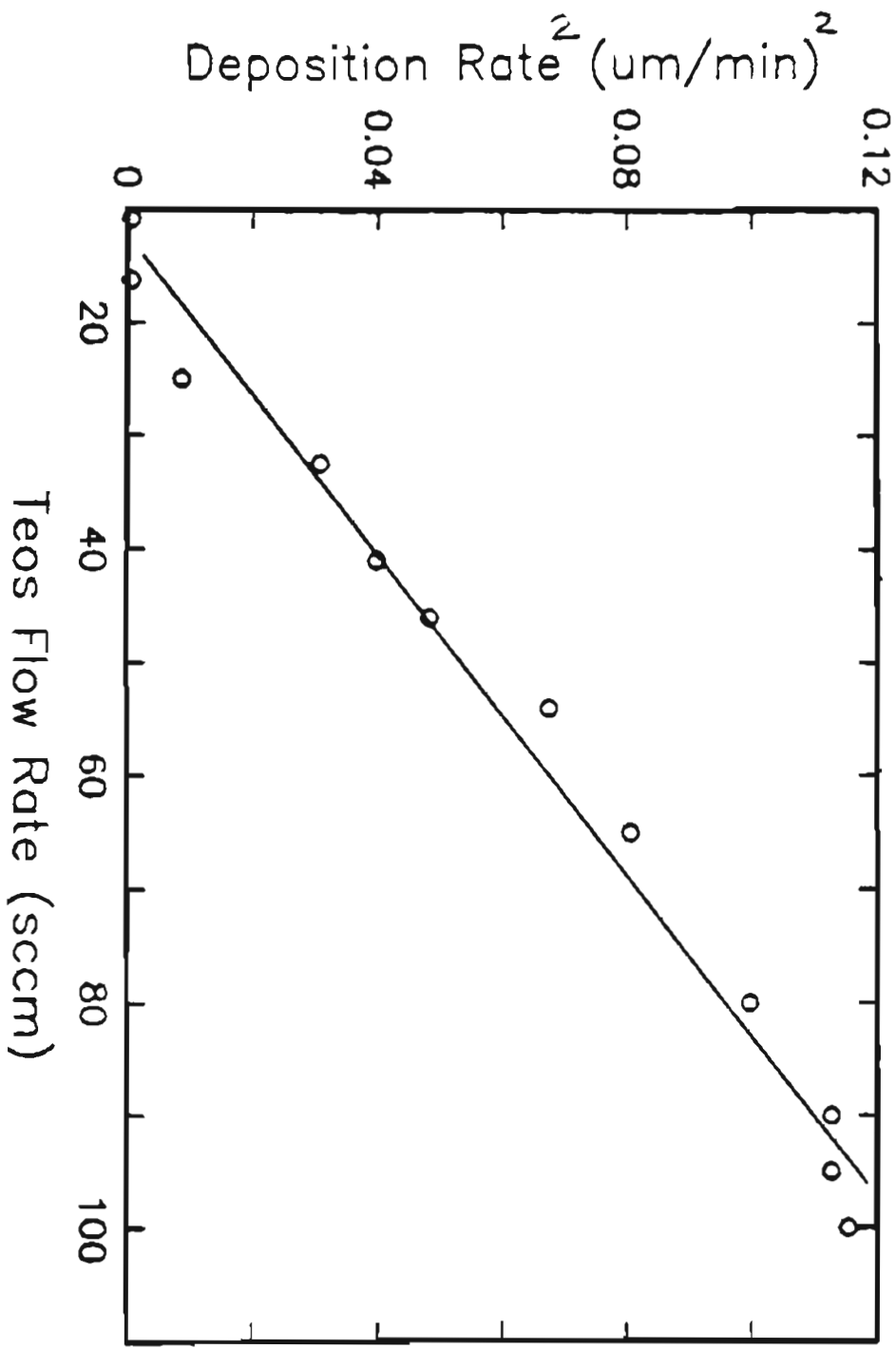
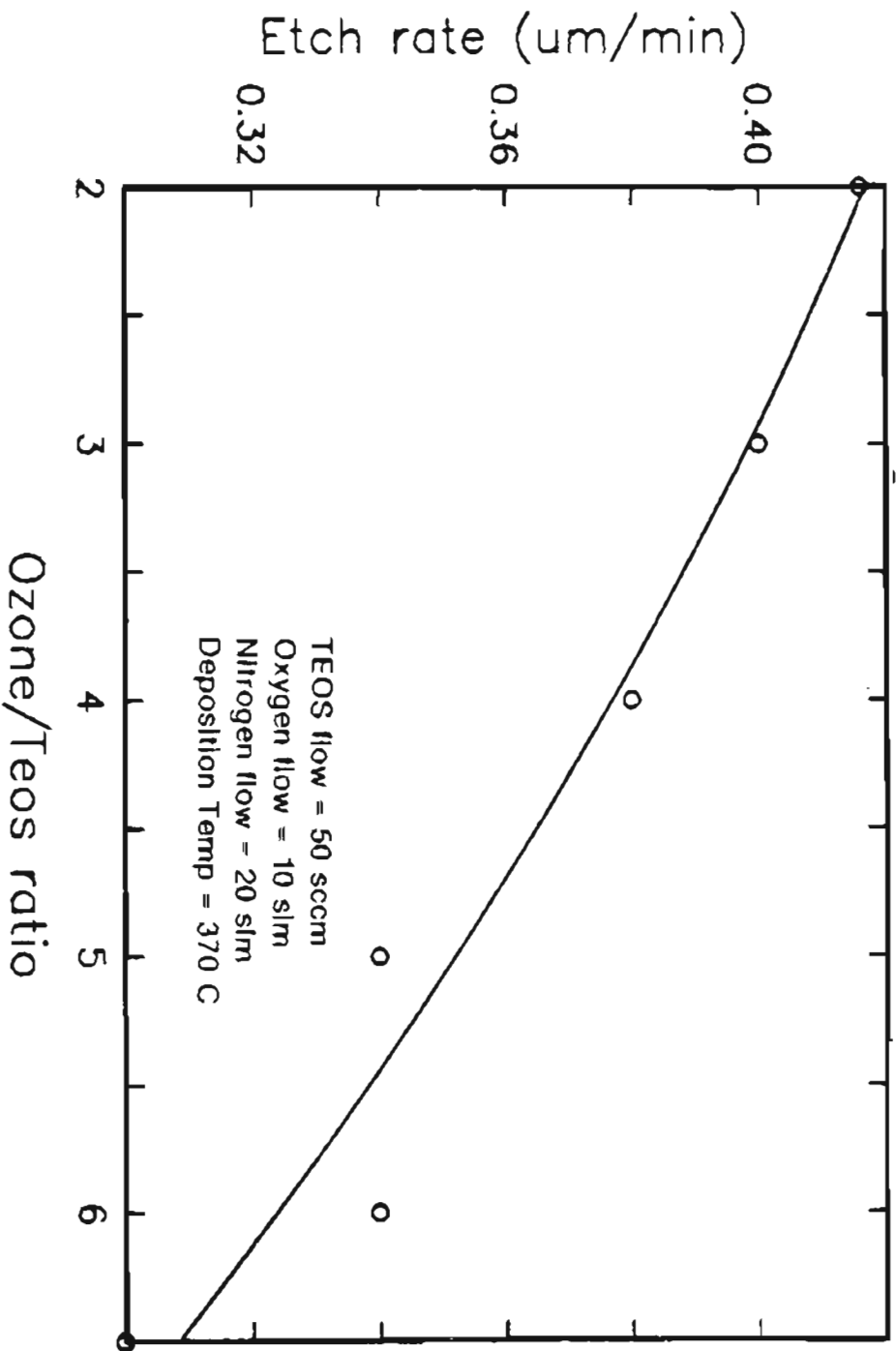


Fig. 16 (Deposition Rate)² Variation with TEOS flow at 20.0 Torr



3 Fig. 17 Etch Rate Variation with Ozone/TEOS Ratio - 200 Torr

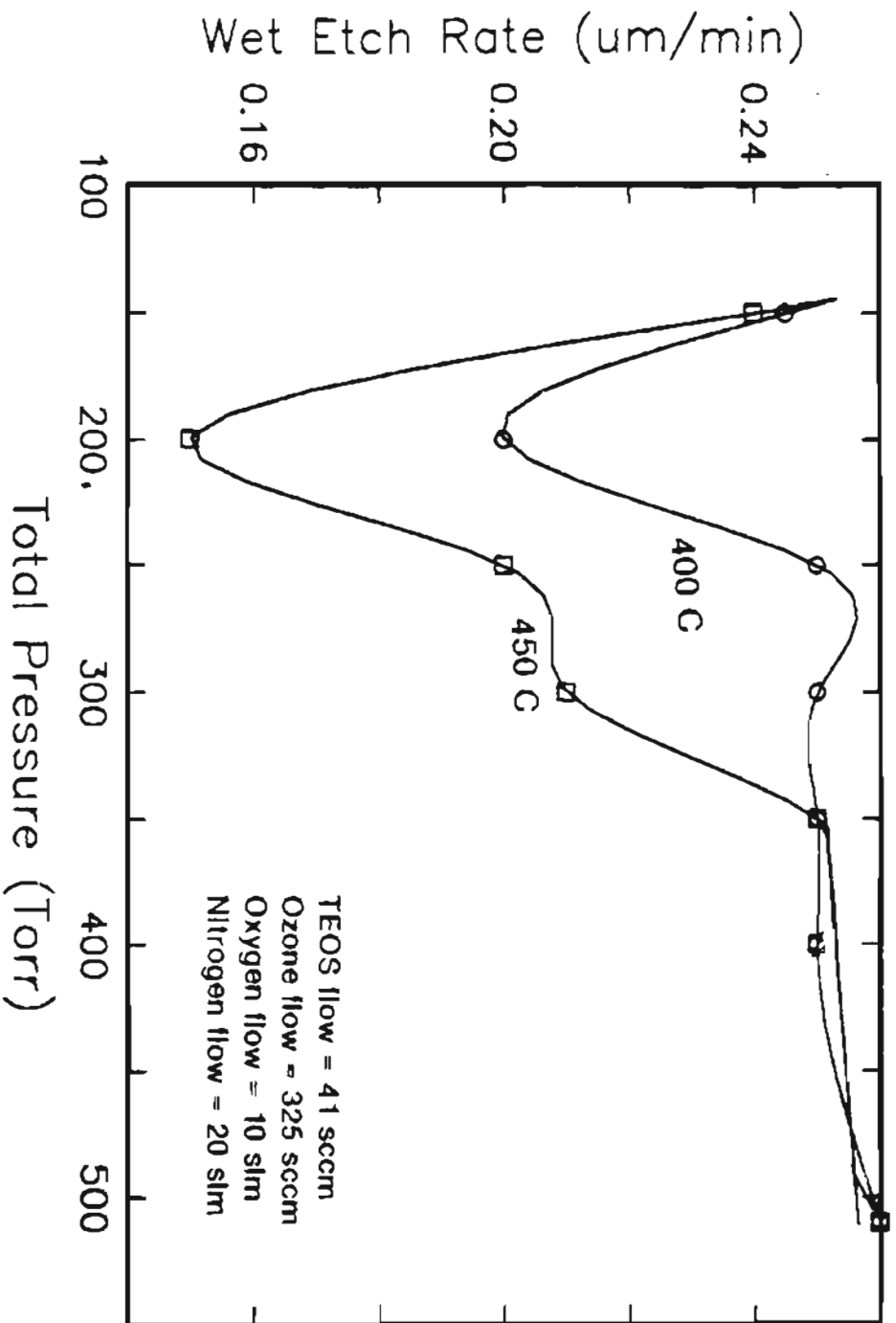


Fig. 19 Effect of Total Pressure on Etch Rate at 400 C and 450 C

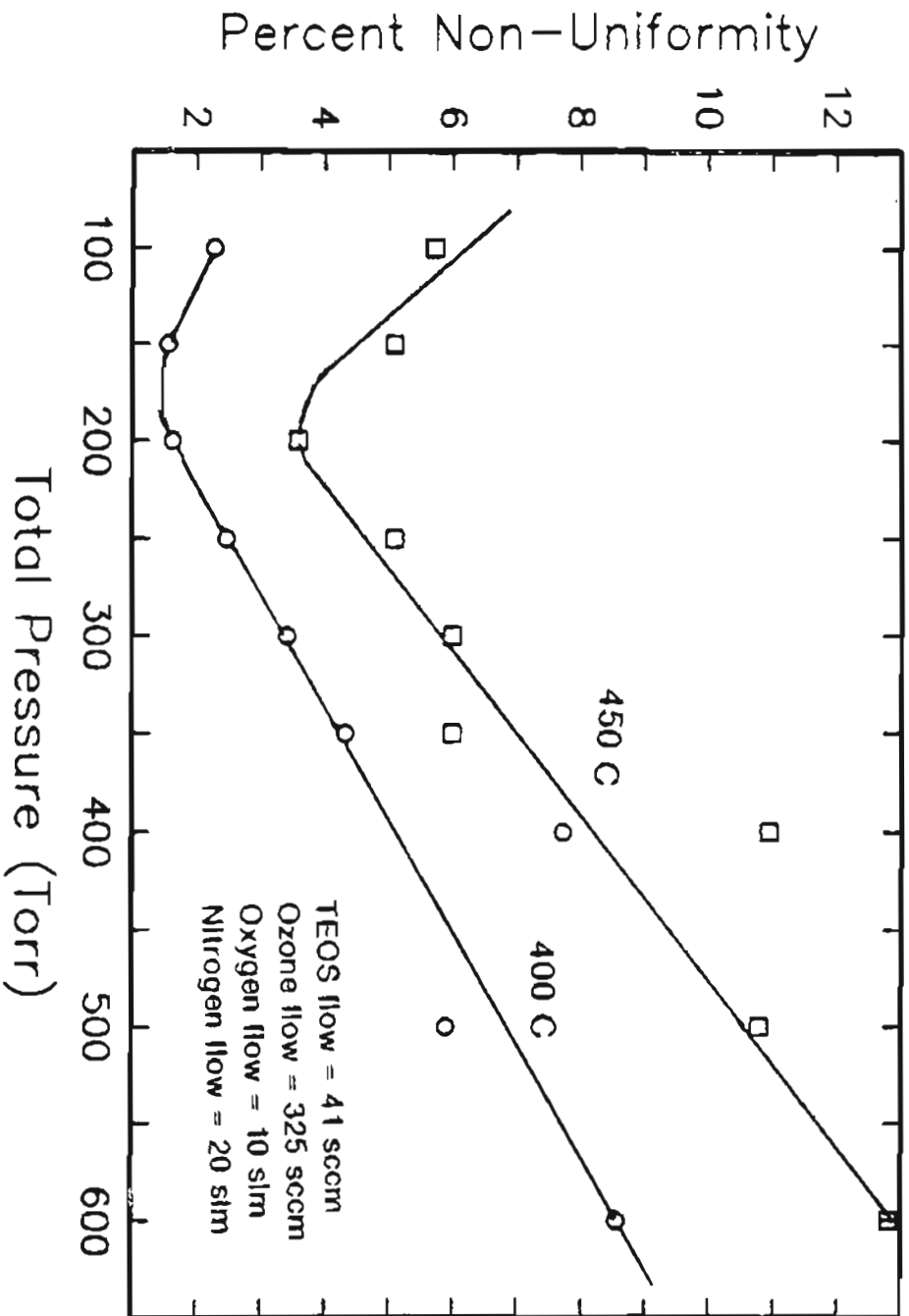


Fig. 20 Effect of Total Pressure on Non-Uniformity, T=400, 450 C

CONCLUSIONS

- DLI system was KEY in characterizing the Ozone/TEOS Process
- Effect of Deposition temperature showed increase - maximum- decrease behavior (decreases at higher temp. due to gas phase reactions)
- The Deposition rate increases with precursor concentrations and saturates at lower deposition temperature - decreases at higher temp.
- The Etch rates decreased with temperature and higher Ozone/TEOS ratio. Measured Etch rates Comparable to PECVD deposition.
- The Process Optimization indicates high deposition rates, low etch rates, high thickness uniformity, and good step coverage around 200 torr at 450 C and Ozone/TEOS = 8 or higher.