

Inhibition of "spontaneous" nucleation¹

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The nucleating ability of silver and lead iodide has been shown (BIRSTEIN, 1957, 1960) to be inhibited by small quantities of methyl and ethyl amines, to be partially inhibited by ethanol, and to be unaffected by isobutane, diethyl ether, *n*-heptane, bromobenzene, and ethylene glycol. The inhibition was attributed in the case of the amines to the formation of co-ordination complexes on the nuclei surfaces. In the present study the inhibition of the "spontaneous" nucleation process was investigated, i.e., nucleation was examined in moist gases with small quantities of chemical vapors present but without solid nuclei in so far as they could be eliminated.

The expansion-chamber technique of CWILONG (1947) was employed. Experimentally, the extent of expansion required of an inert gas above a pool of supercooled (-1°C to -16°C) water to produce freezing of the water was measured. When the expansion (from atmospheric pressure) resulted in the spontaneous formation of ice crystals, the crystals fell into the water and initiated the water's freezing. This latter freezing was detected thermometrically, and served to relate the expansion to the spontaneous nucleation point. The actual nucleation temperature, finally, was calculated from the expansion ratio and the parameters of the system. An IBM Digital Computer was employed; details of the calculations as well as the calibration and checking of the system are given elsewhere (MULLINS *et al.*, 1960; HENDRIX *et al.*, 1961).

With pure oxygen, pure nitrogen, or a volumetric 21%-79% mixture of oxygen and nitrogen as the only gas in the expansion system, spontaneous nucleation temperatures were

found to range between -44.5°C and -46.9°C . These results were obtained after numerous expansions and compressions had been made to eliminate ordinary nuclei from the gases. The expansions, of course, produced progressively lower temperatures as nuclei were removed but a lower limit was reached in the temperature range given. Fig. 1 shows the nucleation temperatures obtained when small amounts of ethyl amine and turpentine vapor were added

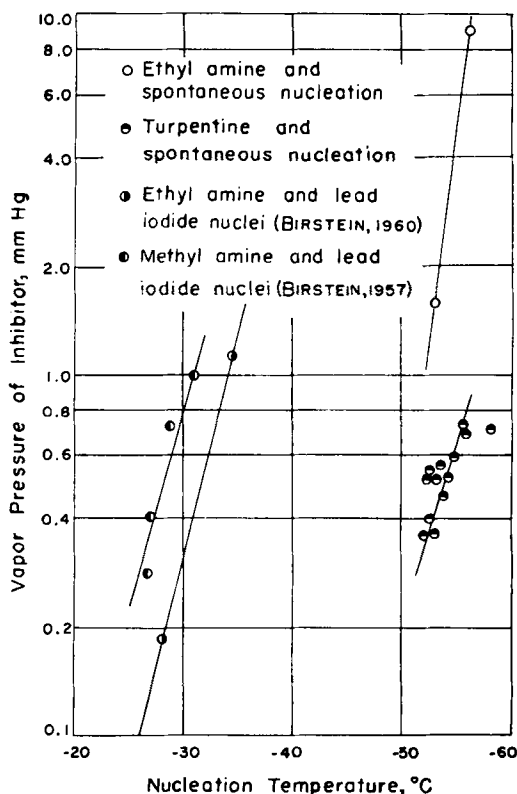


FIG. 1. Water vapor nucleation temperature as a function of chemical vapor concentration.

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to a pure nitrogen atmosphere; the figure also includes results for the inhibition of silver and lead iodide nuclei as obtained previously (BIRSTEIN, 1957, 1960). Benzene, aniline, n-butanol, and 2-methyl-2-butene were found to exert an insignificant influence on the spontaneous nucleation process.

The freezing temperature of water droplets is a function of the droplet diameter, a temperature

of about -40°C being found for droplets of 1 micron diameter (MASON, 1957). The droplets as condensed in this study must have been somewhat smaller than 1 micron, and they must have formed about nuclei of still smaller diameter. These nuclei are inhibited by certain chemicals even though they are not removed by repeated expansions.

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