Yu. M. Aleksandrov, A. D. Krivospitskiĭ, and M. N. Yakimenko. *X-ray lithography in synchrotron radiation beams*. Modern integrated circuits make extensive use of structures with component dimensions of ~1.5–2.0 μm. They are made by photographic techniques; mercury quartz lamps are used as light sources for this purpose. Further microminiaturization, i.e., the transition to submicron component dimensions, would make it possible not only to raise the degree of integration of the microcircuits to the level of 10^5–10^6 components per crystal, but also to create a number of fundamentally new devices. However, diffraction distortions make it impossible to obtain lines narrower than 1 μm at the wavelengths of visible light.

Accordingly, the use of harder electromagnetic radiation—the x-ray lithography technique—is of great interest. Radiation at wavelengths of 10–50 Å is most promising for a number of technological and physical reasons.

Sources of such radiation can be found in high-power x-ray tubes and the synchrotron radiation (SR) of ring accelerators and electron storages. It can be shown that SR has the advantage because it reproduces drawings of the structures in superior fashion and requires only 1/100–1/1000 as much exposure time.

A special-purpose SR channel has been built at the P. N. Lebedev Physics Institute of the Academy of Sciences of the USSR for the S-60 synchrotron in a joint effort with the Scientific Research Institute of Physical Problems for use in developing a technology for producing imprints of submicron structures. The channel is equipped with a camera for specimen exposure and optical diagnostic equipment for the electron beam. Its automatic SR-beam specimen-scanning system makes it possible to produce large (100×100 mm) imprints of submicron structures. Figure 1 is a photograph of a structural-topology picture obtained with SR on a PMMA film 0.4 μm thick. The exposure time for a silicon template membrane 2 μm thick was 30 sec, and the circuit-element dimension ≈1.2 μm. Figure 2 shows a photograph of a test-line image ob-

FIG. 1.

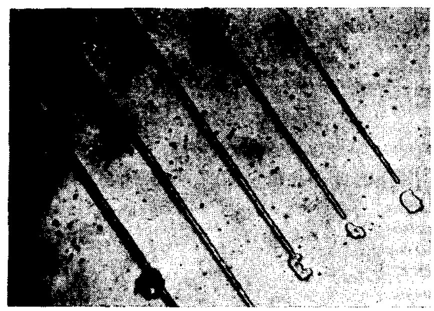

FIG. 2.

tained in a film of x-ray resist; the smallest line width is 0.3 μm. The high quality of the prints, which is obtained by virtue of the high natural collimation of synchrotron radiation, is evident.

[1]Yu. M. Aleksandrov *et al.*, FIAN SSSR Preprint No. 237, Moscow, 1978.
[2]E. Spiller *et al.*, DESY Preprint SR 76/11.
[3]R. Fedev *et al.*, DESY Preprint SR 77/06.