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RELATIVE SPECTRAL RESPONSE CURVES

FOR

SEMICONDUCTOR INFRARED DETECTORS

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FOREWORD

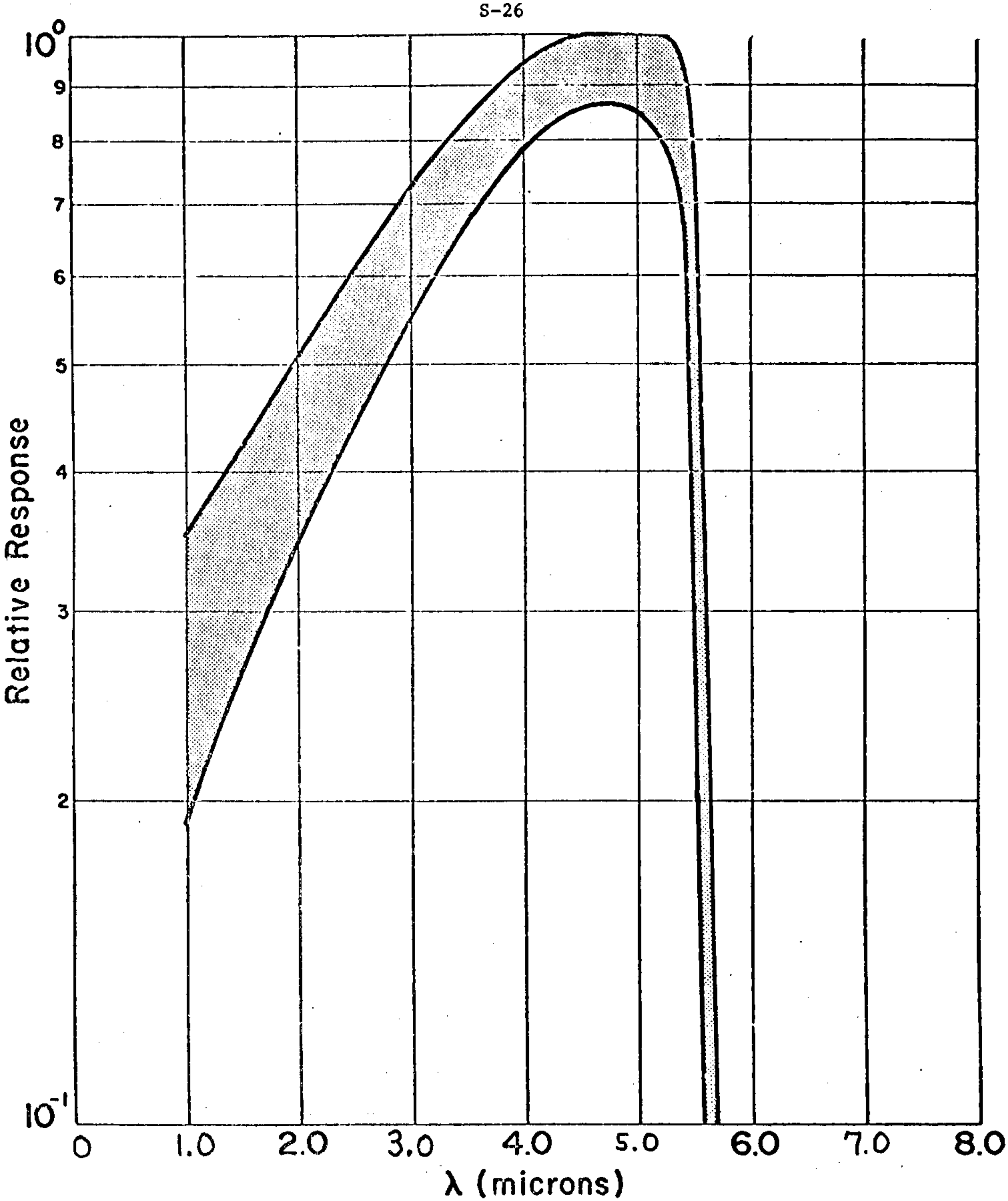
The S-curves appearing in this publication were compiled by the JS-4* Committee on Solid State Electro-Optical Devices and approved by the JEDEC Semiconductor Device Council. The intent of this document is to facilitate the specification of infrared detector diodes, particularly in conjunction with the preparation of data for JEDEC type registration.

*JS-4 gratefully acknowledges the assistance of Mr. W.L. Eisenman, Head, Detector Brand, Infrared Division, U.S. Naval Ordnance Laboratory, Corona, California, who was on the JS-4 task force that made the compilation.

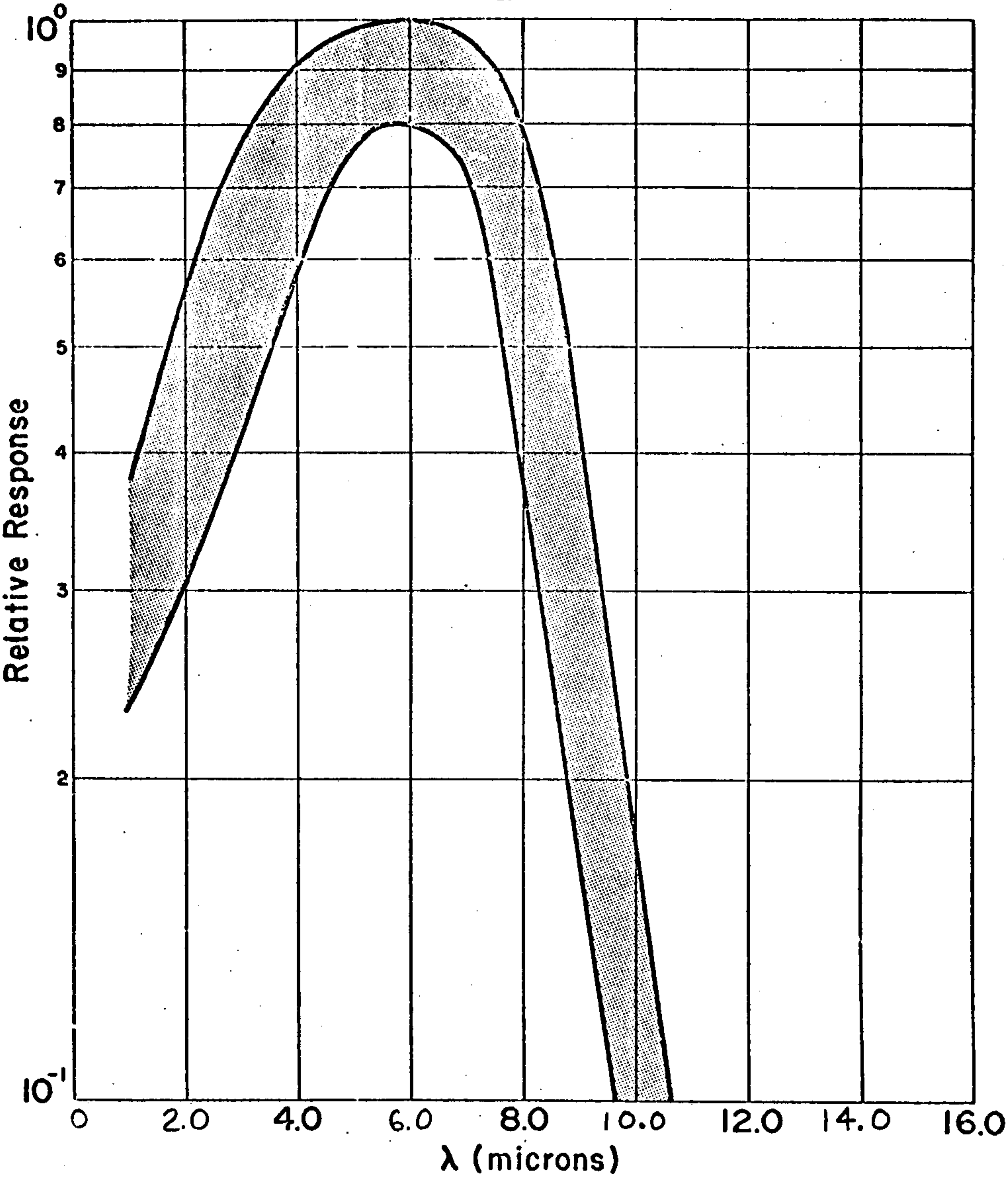
SECTION I RELATIVE SPECTRAL RESPONSE CURVE

S-No.	Photoeffect	Nominal Components	Operating Temperature (°K)
S-26	photovoltaic	InSb	77
S-27	photoconductive	Ge:Au	77
S-28	photovoltaic	InAs	195
S-29	photoconductive	PbSe	77
S-30	photoconductive	Ge:Cu	4.2
S-31	photoconductive	PbS	300
S-32	photoconductive	PbS	195
S-33	photoconductive	PbS	77
S-34	photovoltaic	InAs	300
S-35	photoconductive	InSb	77
S-36	photovoltaic	GaAs	300
S-37	photovoltaic	Si	300
S-38	photoconductive	PbSe	300
S-39	photoconductive	PbSe	195
S-40	photoconductive	Ge:Hg	4.2

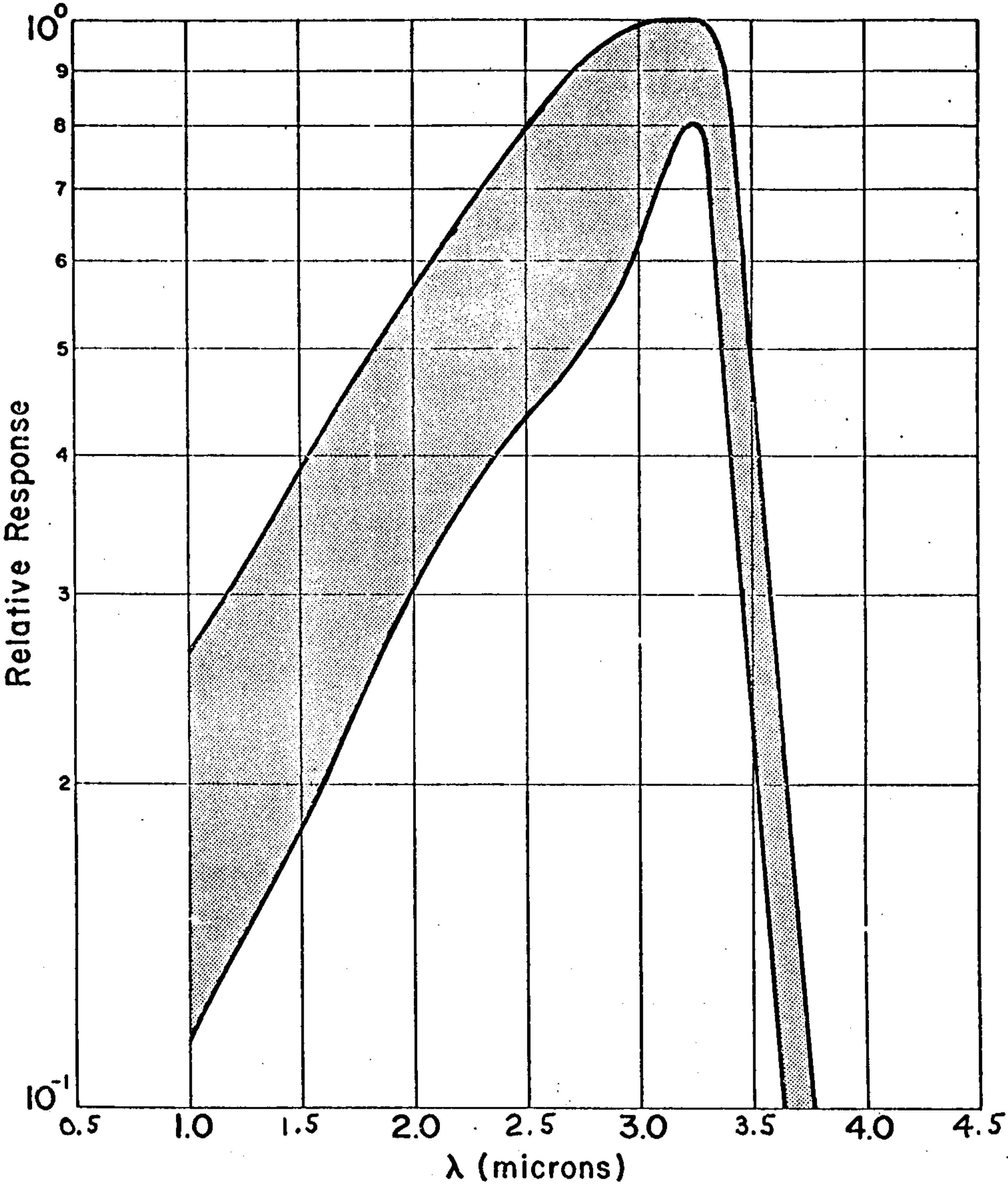
The shaded areas of the following S-curves indicate the range of spectral shapes which may be expected if a particular type photodetector is obtained from several different manufacturers. It should be noted that the spectral response of some types of photodetectors (particularly the lead-salt and intrinsic silicon detectors) can be varied during the manufacturing process. The curves shown here are representative of the more common, or "typical," detector types.



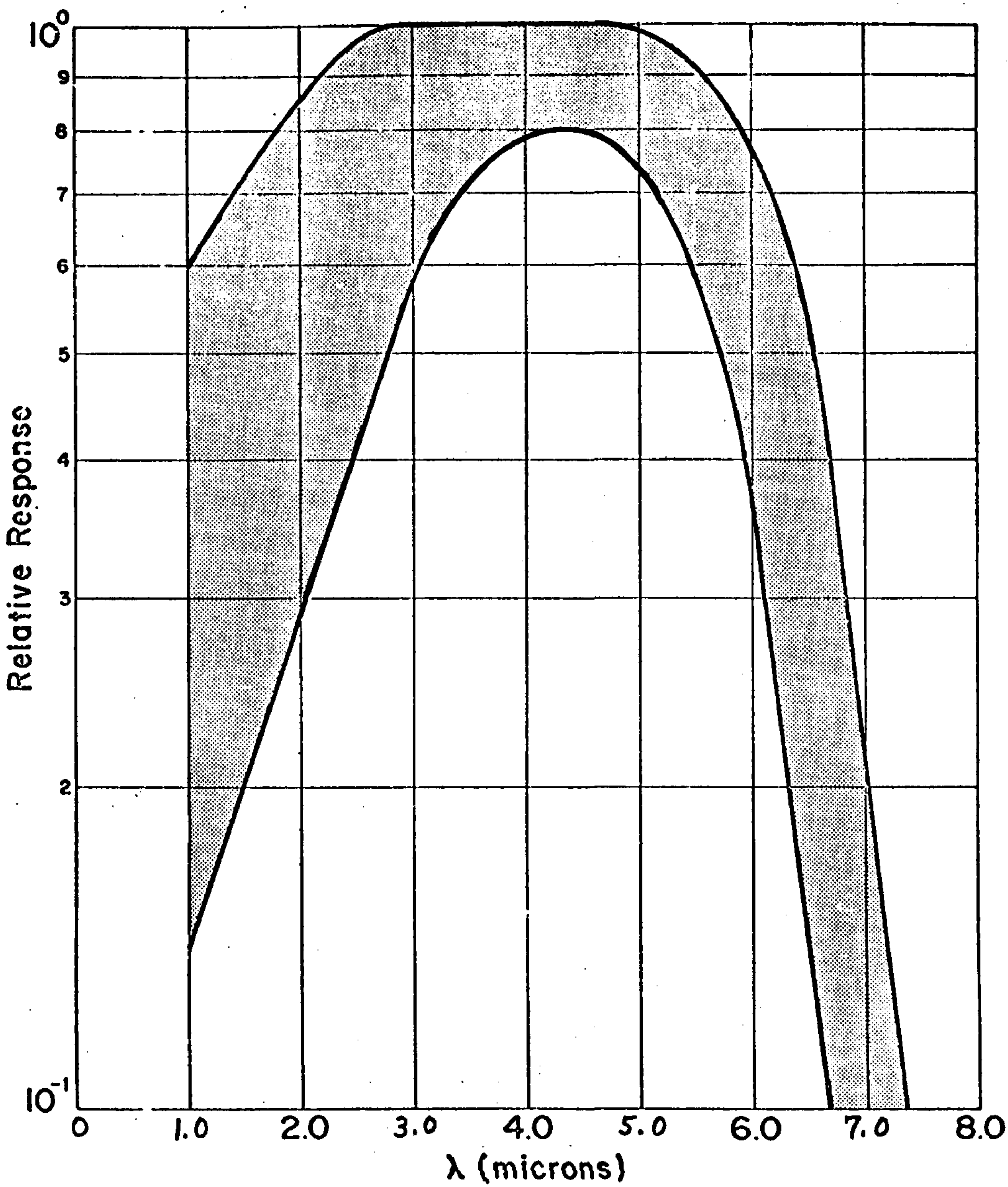
The spectral sensitivity of photovoltaic InSb operated at a temperature of 77°K.



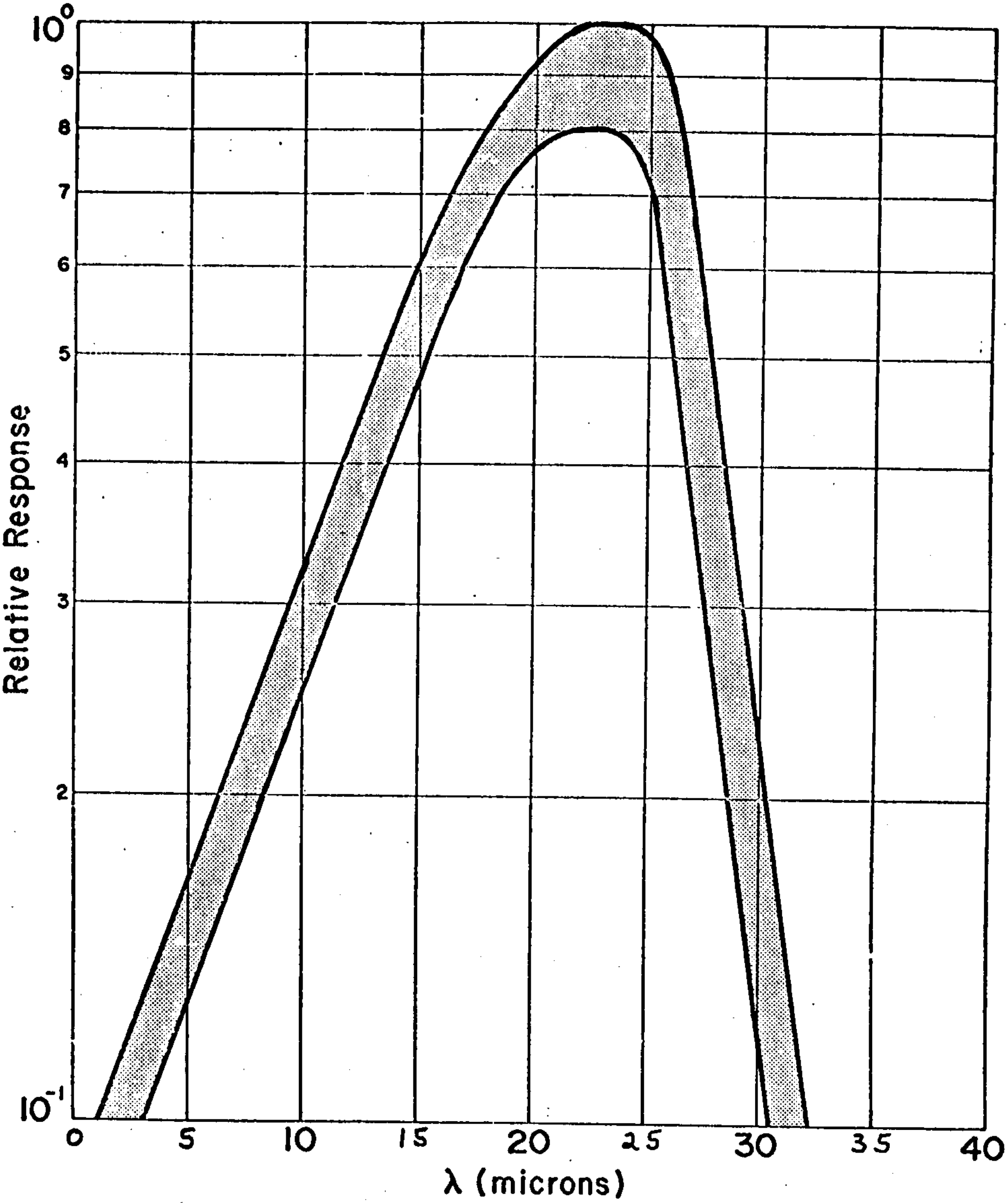
The spectral sensitivity of photoconductive Ge:Au operated at a temperature of 77°K.



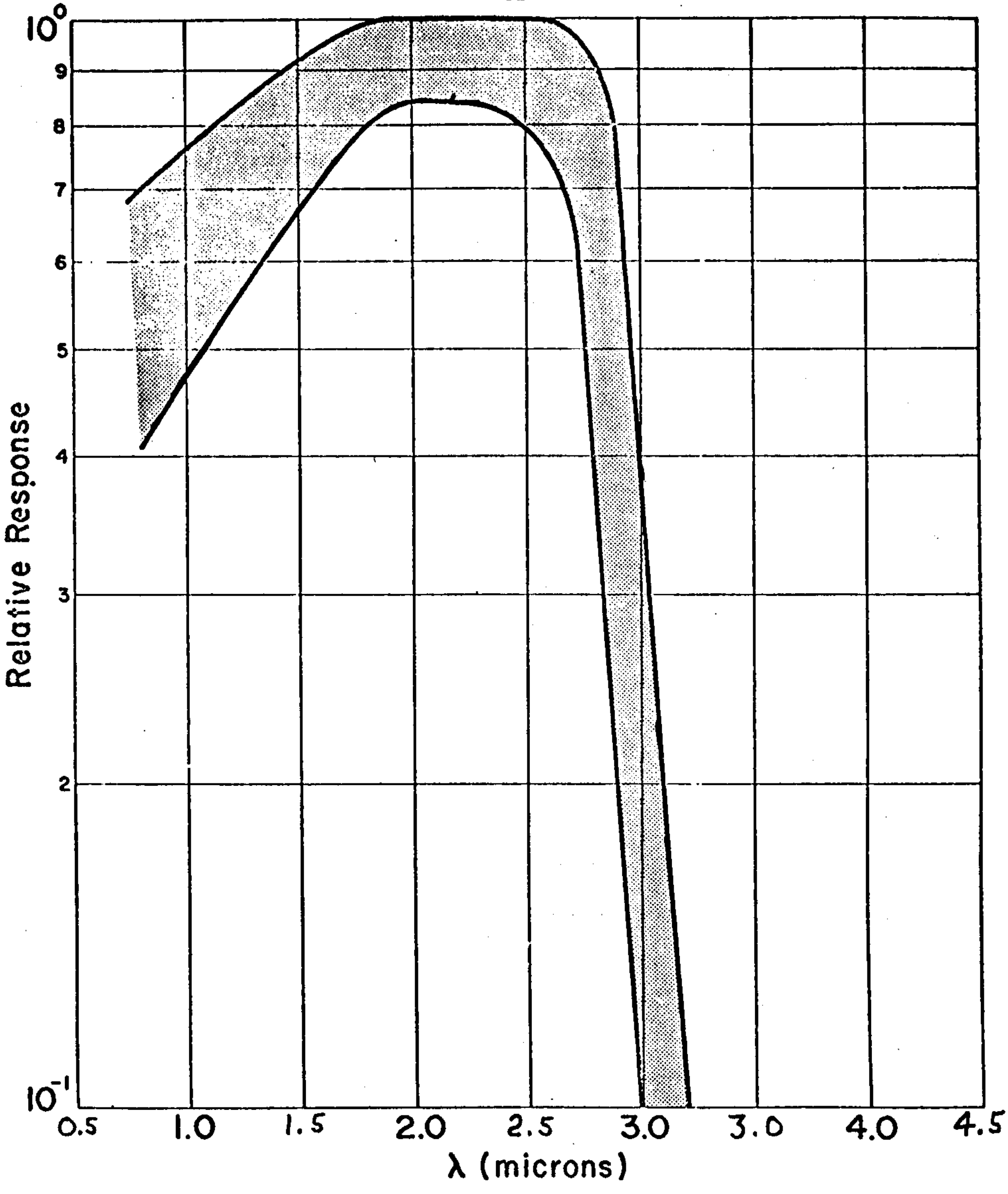
The spectral sensitivity of photovoltaic InAs operated at a temperature of 195°K.



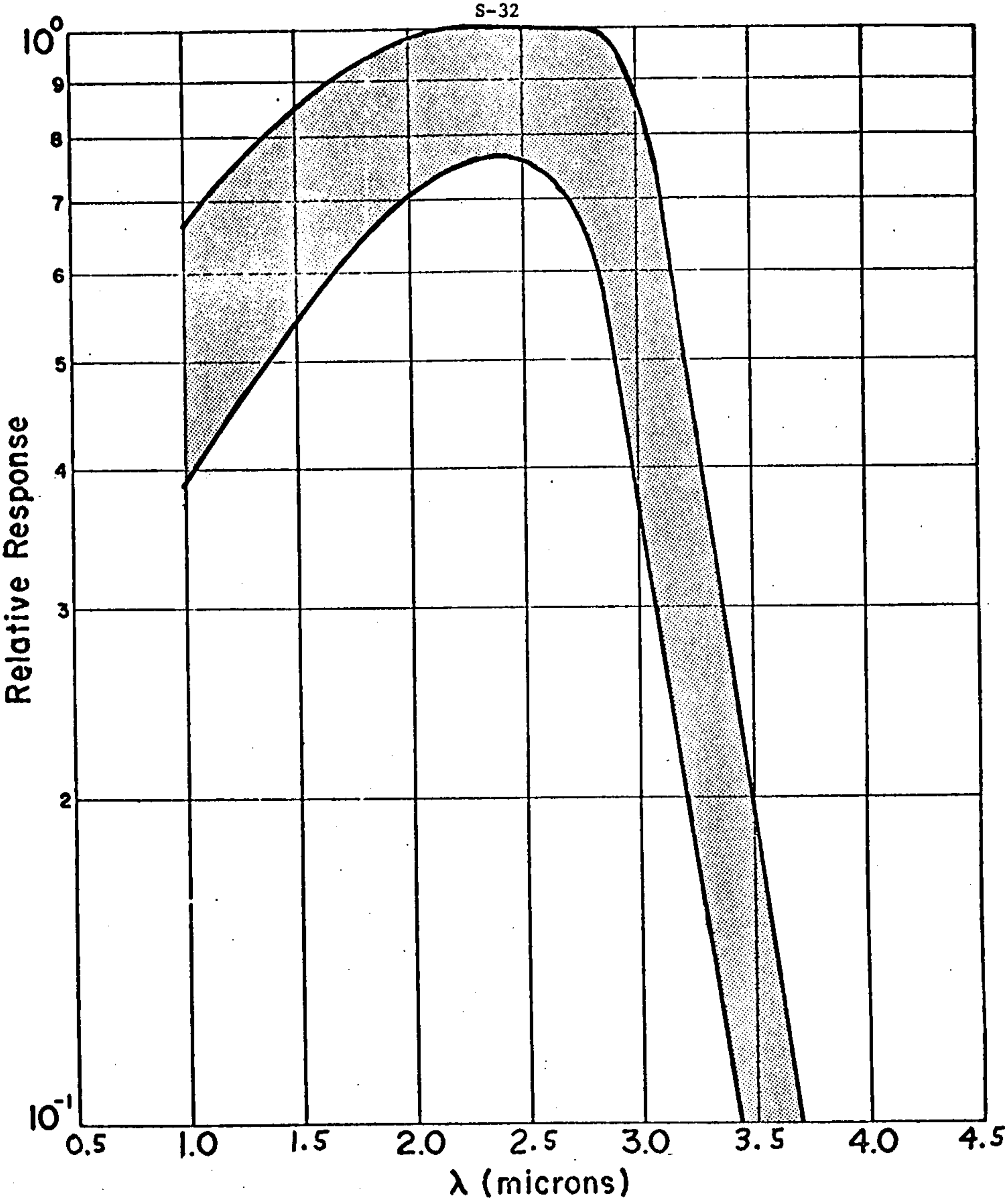
The spectral sensitivity of photoconductive PbSe operated at a temperature of 77°K.



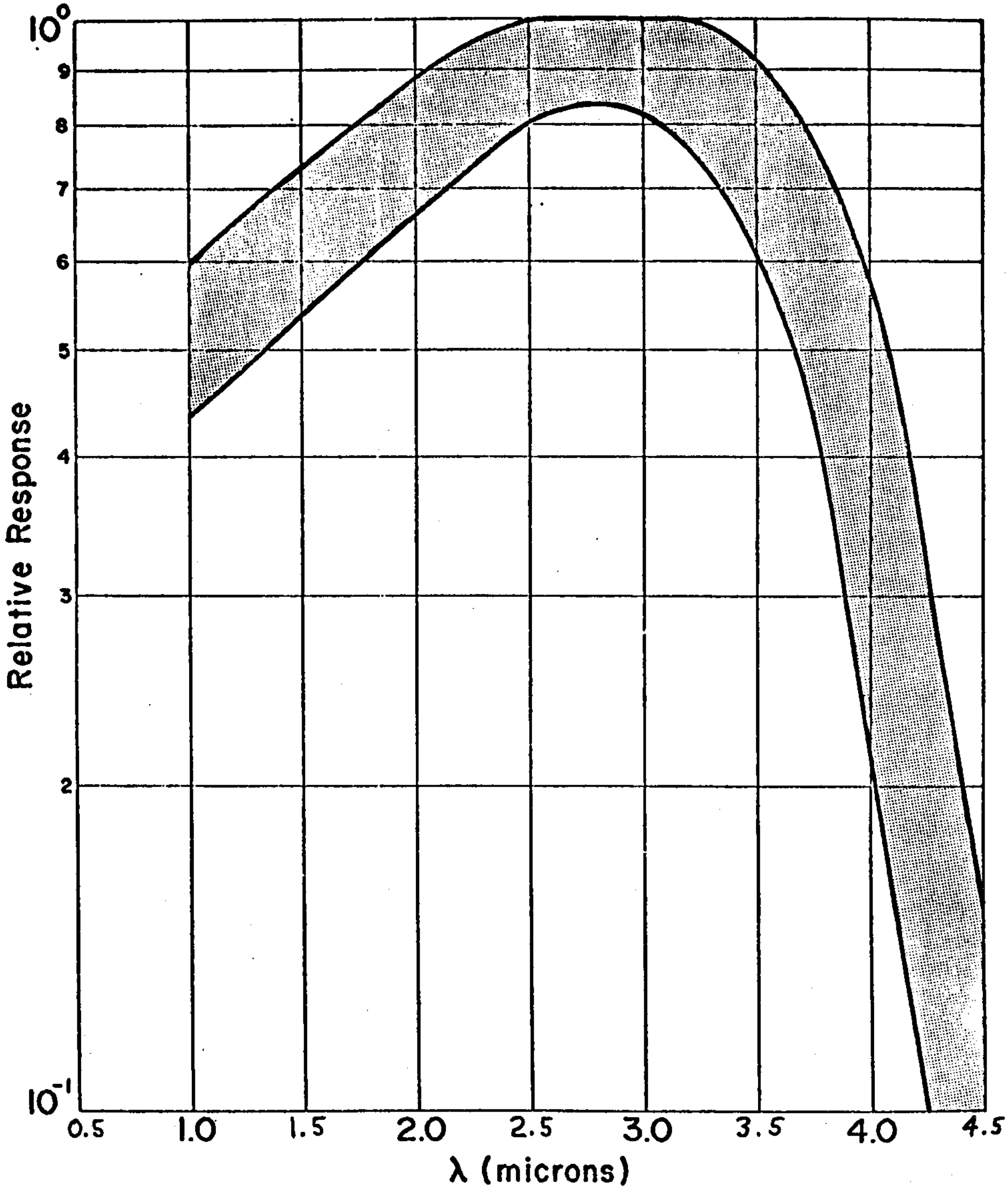
The spectral sensitivity of photoconductive Ge:Cu operated at a temperature of 4.2°K.



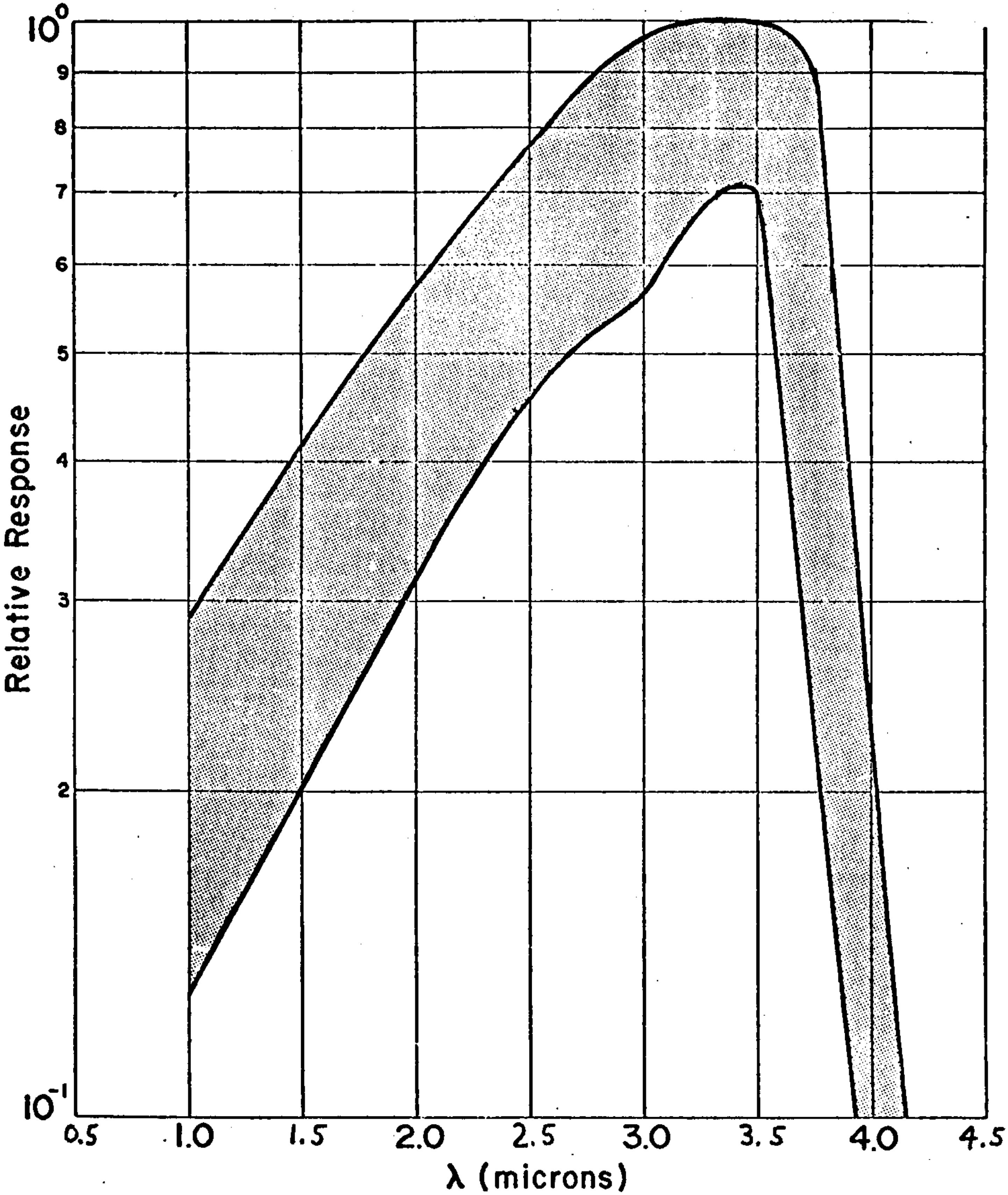
The spectral sensitivity of photoconductive PbS operated at a temperature of 300°K.



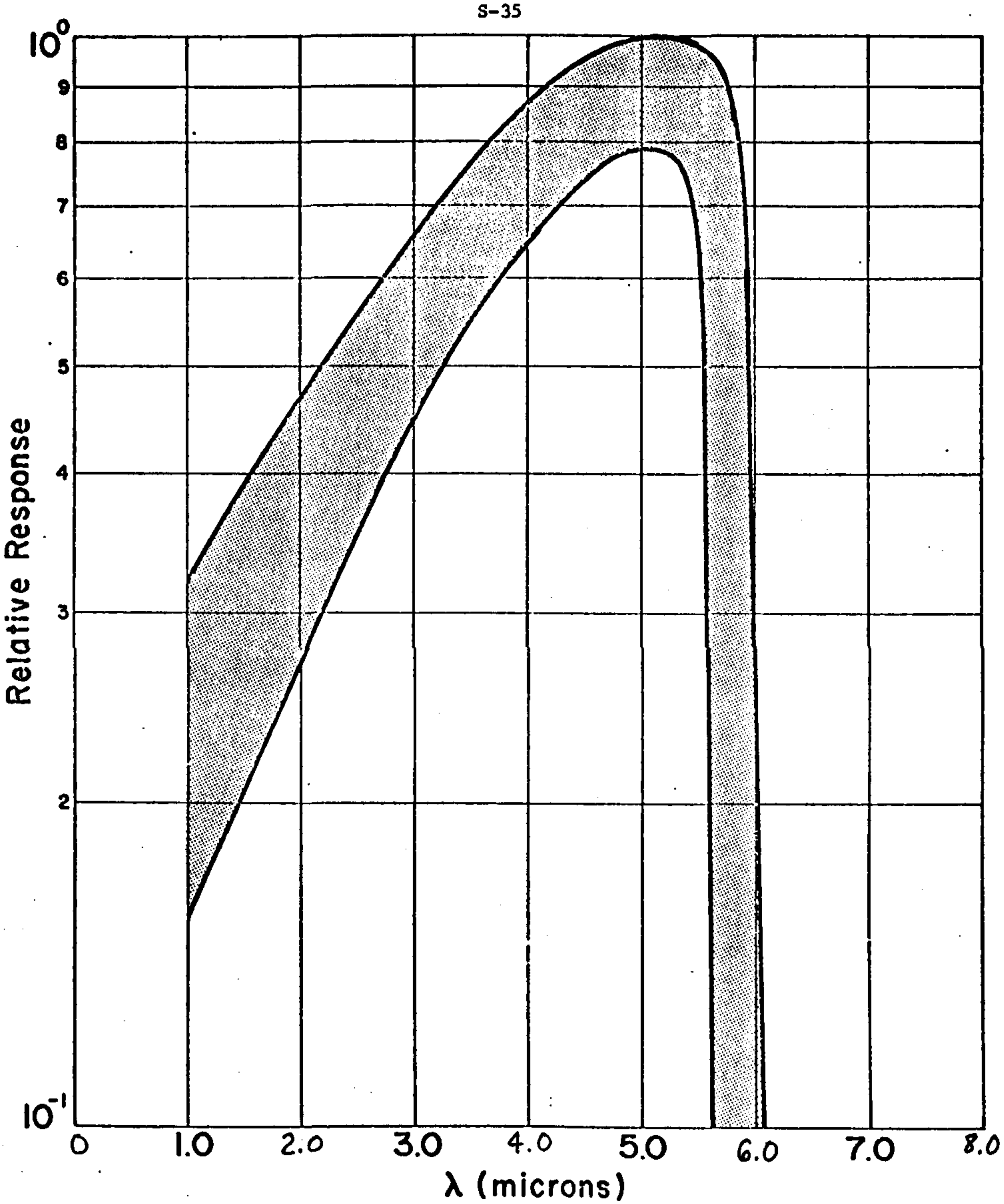
The spectral sensitivity of photoconductive PbS operated at a temperature of 195°K.



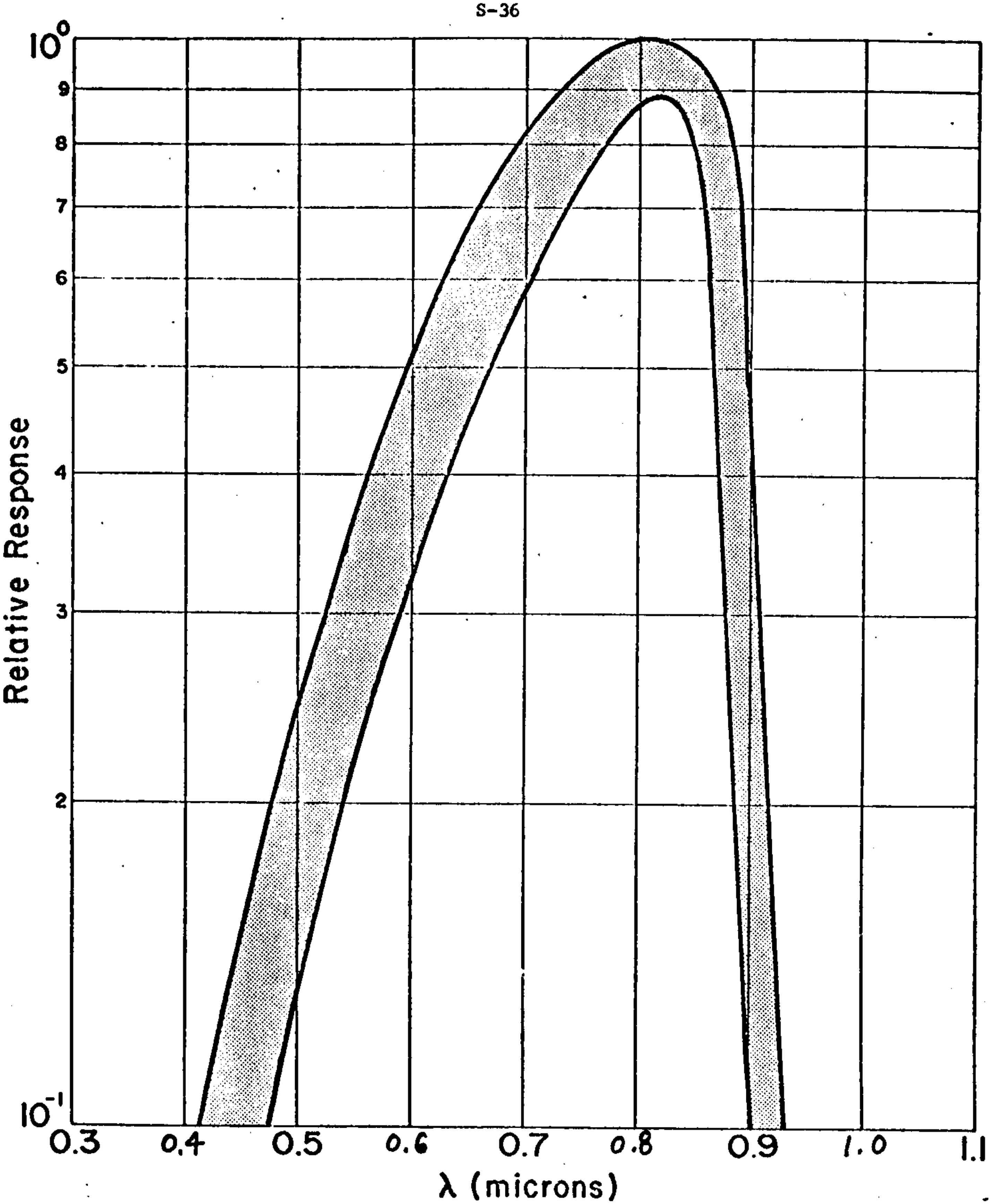
The spectral sensitivity of photoconductive PbS operated at a temperature of 77°K.



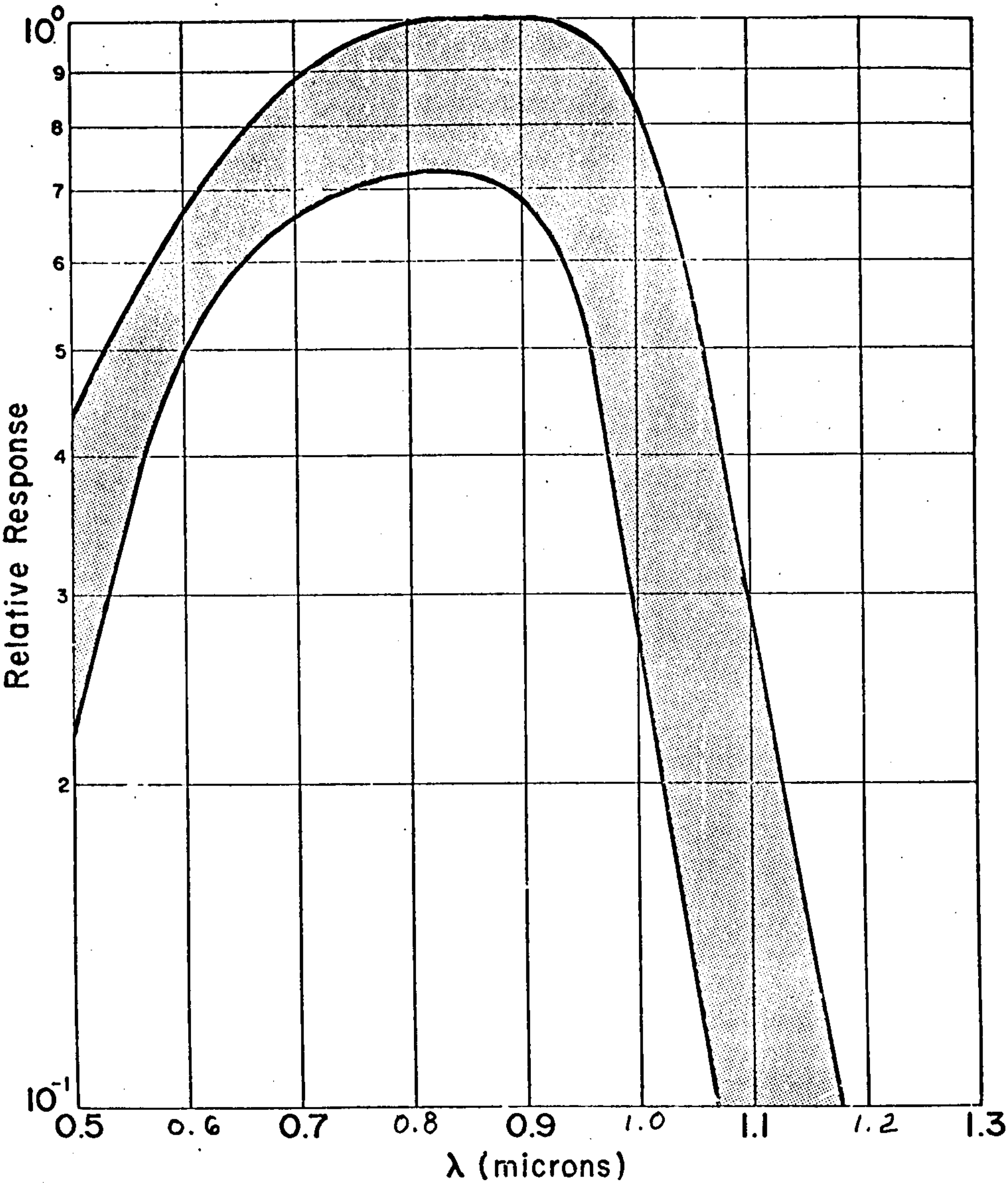
The spectral sensitivity of photovoltaic InAs operated at a temperature of 300°K.



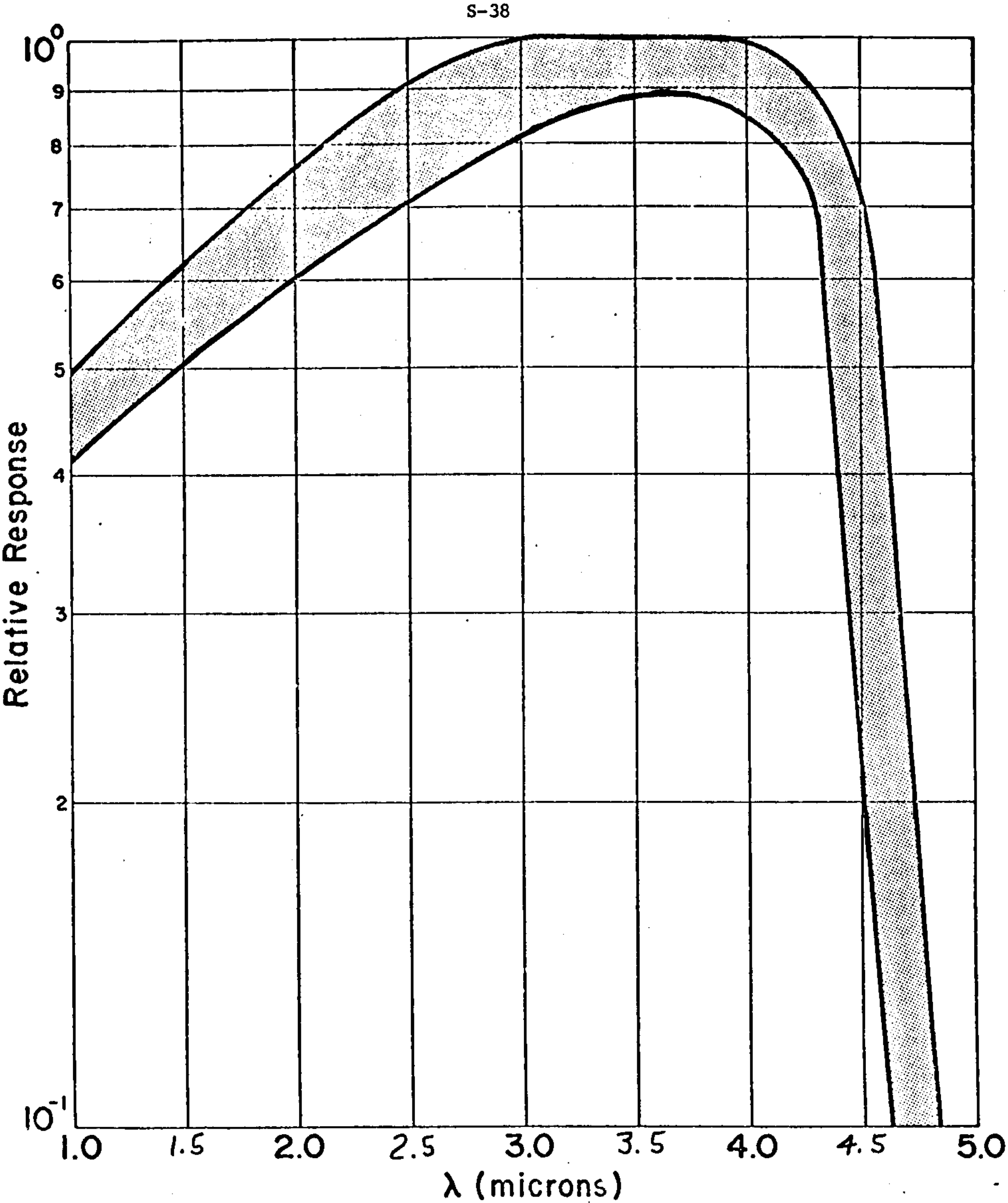
The spectral sensitivity of photoconductive InSb operated at a temperature of 77°K.



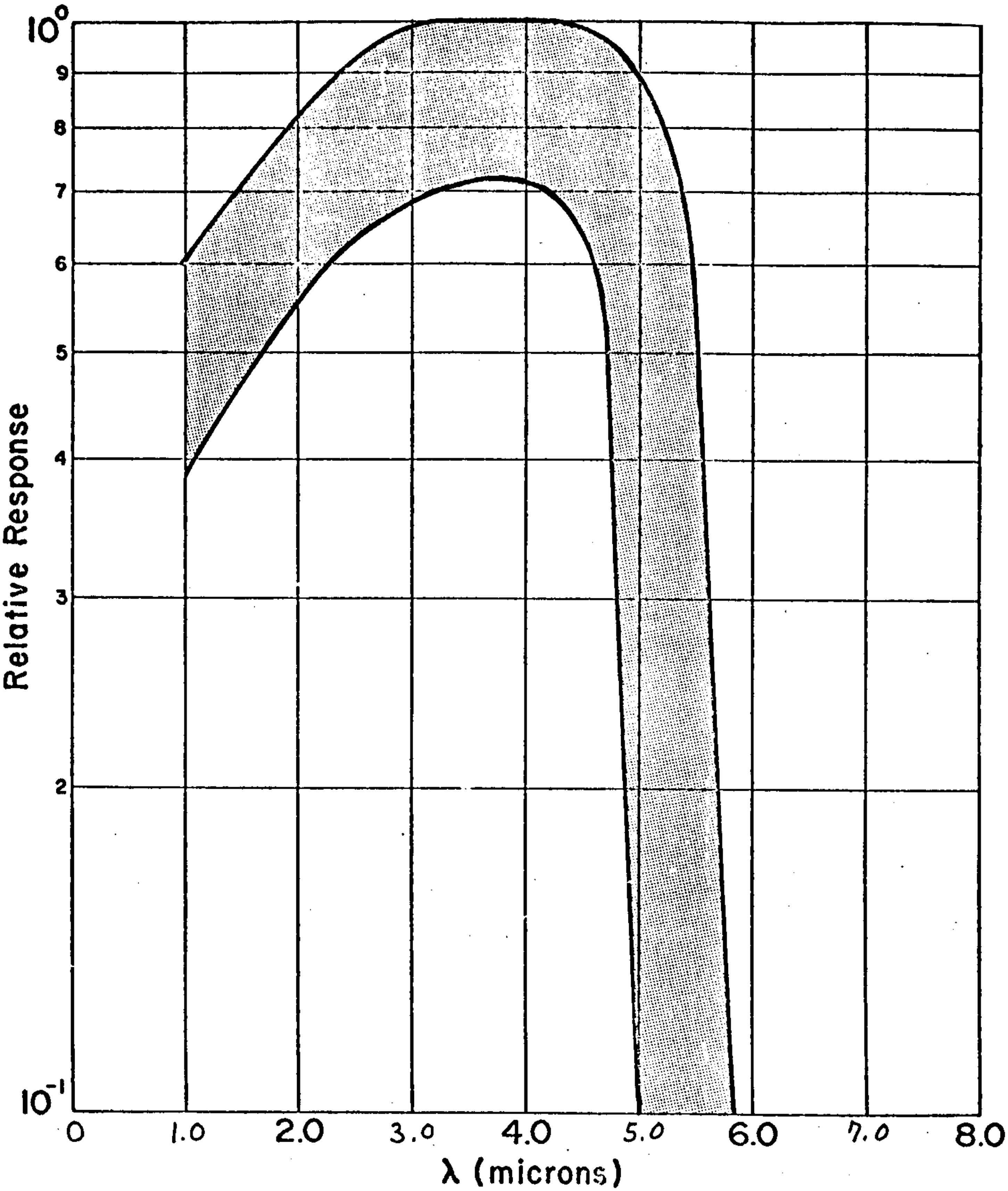
The spectral sensitivity of photovoltaic GaAs operated at a temperature of 300°K.



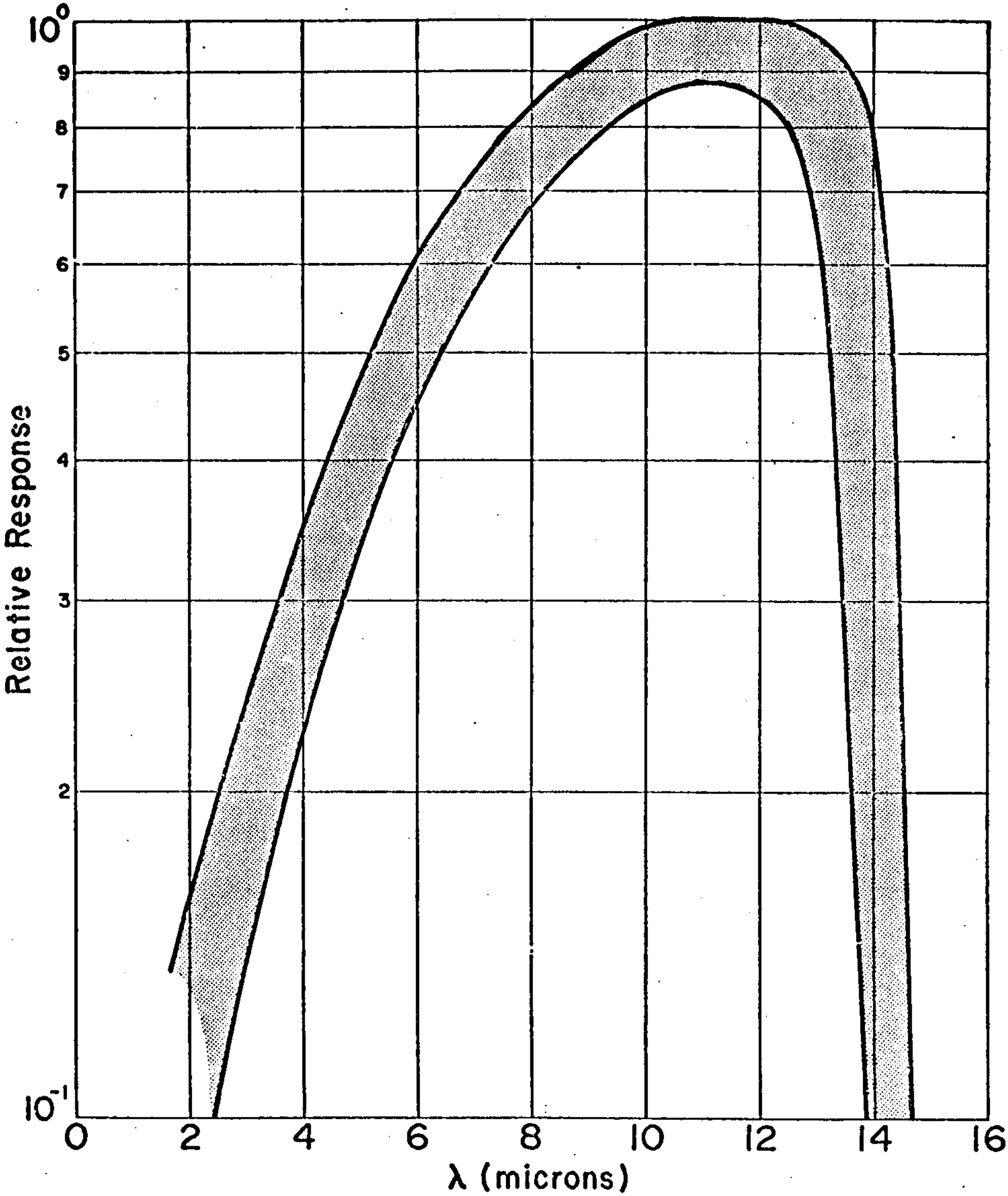
The spectral sensitivity of photovoltaic Si operated at a temperature of 300°K.



The spectral sensitivity of photoconductive PbSe operated at a temperature of 300°K



The spectral sensitivity of photoconductive PbSe operated at a temperature of 195°K.



The spectral sensitivity of photoconductive Ge:Hg operated at a temperature of 4.2°K

SECTION II MEASUREMENT PROCEDURES

The spectral response curves were obtained using Leitz (or equivalent) double monochromators. Three instruments, equipped with calcium fluoride, sodium chloride, and cesium iodine prisms, cover the spectral region of 0.3 to 40 microns. These instruments have proven convenient to use and relatively inexpensive, and the scattered light at the third slit is very small. (With one millimeter slits and a sensitive lead sulfide detector placed at the exit slit, no scattered energy is detected beyond the long wavelength cutoff of the detector.)

Each instrument is equipped with an optical bench which is securely attached to the base of the instrument, in line with the exit slit. This bench supports several optical elements and a radiation thermocouple which is used as a reference detector. A first-surface plane mirror is arranged so that it can be alternately introduced or removed from the optical path. The instruments are also equipped with entrance optics, tungsten or Nernst glower sources, and 90 Hz and 10 Hz choppers. Both choppers are placed in the entrance beam. The 90 Hz chopper is used for the detector channel and the 10 Hz chopper for the thermocouple channel. The complete optical arrangement is shown schematically in Fig. 1. (Those mirrors not common to both the reference source and the device under test must be of such quality so as not to affect the spectral transmission.)

The detector electronics consist of a cathode follower mounted in the detector enclosure, a preamplifier, and a narrowband tuned amplifier having a 5 Hz bandpass and a center frequency of 90 Hz. The thermocouple signal is amplified by means of a second narrowband tuned amplifier with a center frequency of 10 Hz and bandpass of 1 Hz. It is found convenient to operate both choppers simultaneously during the measurement.

The relative spectral response of the detector is calculated from

$$R_d(\lambda) = \frac{S_d(\lambda)}{S_t(\lambda)} \cdot R_t(\lambda)$$

where

$S_d(\lambda)$ = the signal from the detector.

$S_t(\lambda)$ = the signal from the thermocouple.

$R_t(\lambda)$ = the relative spectral response of the thermocouple.

The ideal reference detector would have a flat spectral response, good linearity and stability, high detectivity, and a fast response time. Lacking a reference detector with these characteristics, it is common practice to use a radiation thermocouple whose spectral characteristics have been experimentally determined. 1/

1/ W.L. Eisenman, et al., "Black Radiation Detector", J. Opt. Soc. Am., Vol. 53, 729-734, June 1963.

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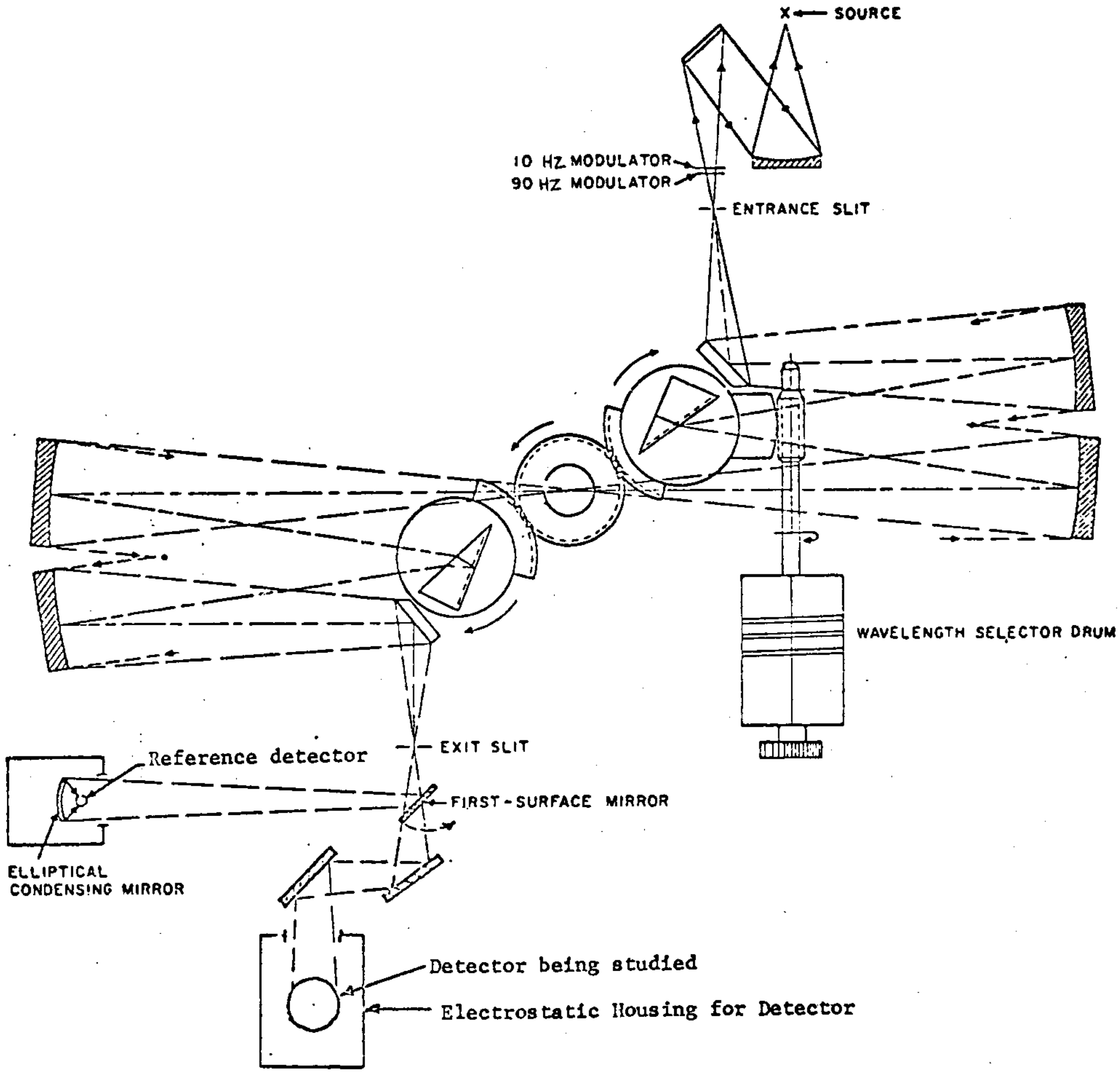

FIGURE 1 Schematic of Leitz Monochromator and Optical Bench

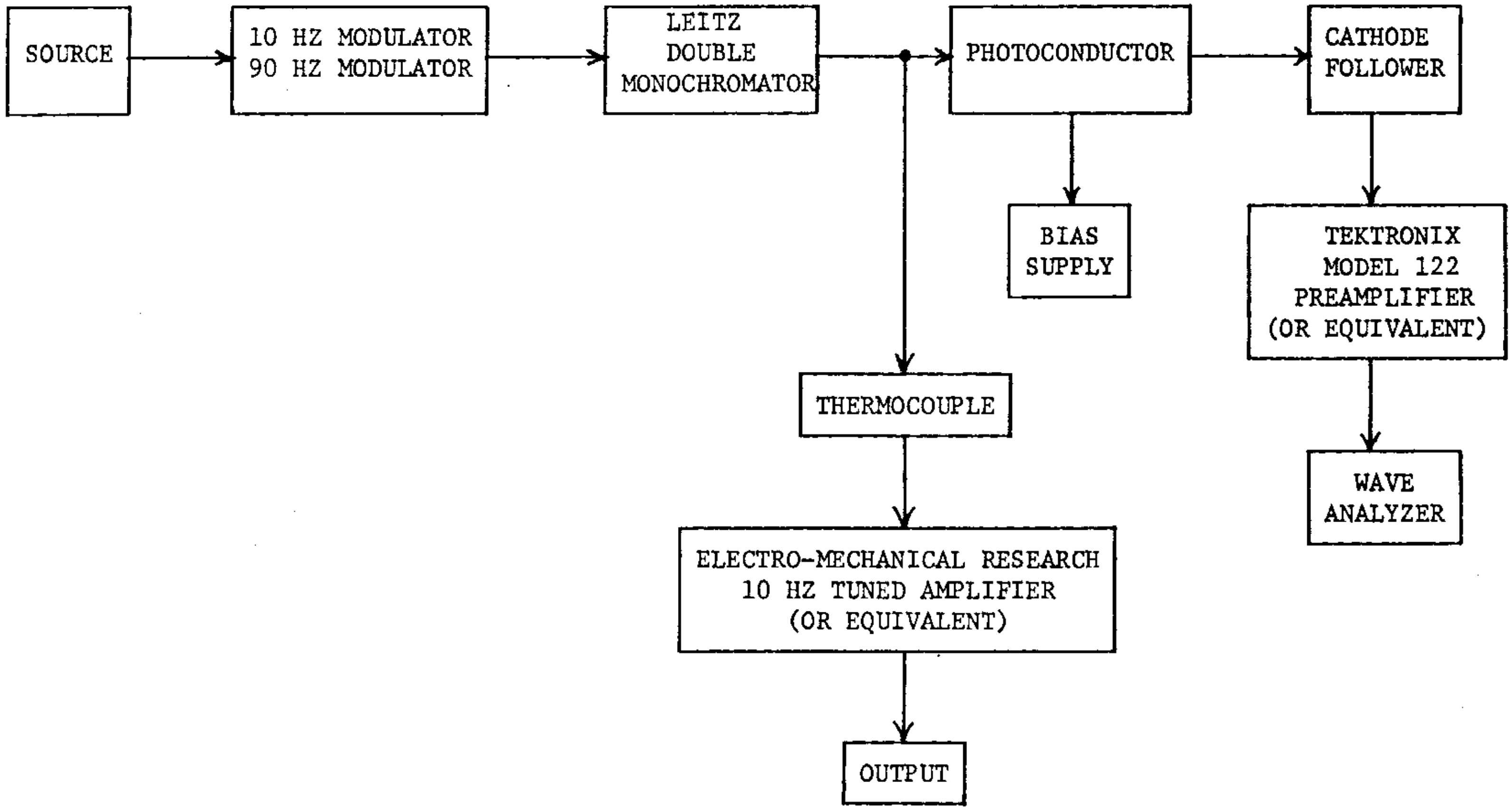

FIGURE 2: Block Diagram of Spectral Response Equipment

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