SOURCES FOR THE PRODUCTION AND CONTROL OF DEEP ULTRAVIOLET RADIATION

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Abstract
Multi-level resist technology is rapidly emerging as a technique capable of significantly improving processes needed to acheive desired yeilds on VSLI products. For the multi-level resist technology to be successful, production-rated Deep Ultraviolet (DUV) exposure systems will be required.

Introduction
This presentation describes the two critical components of a Deep UV Exposure System: the source to produce the radiation; and the optical elements needed to collect, shape, and deliver the radiation to the wafer plane. For purposes of this discussion, I will primarily focus on radiation in the 200 – 315nm region and, in particular, the 200 – 260nm region where PMMA is used as a base resist.

Sources that emit DUV radiation are:

1) Deuterium: although it produces a continuum in the region from 200 to 315nm, it finds limited application because of its low output levels. Until lamps can be made to handle more than 200W, deuterium cannot be seriously considered, except as an R&D tool.

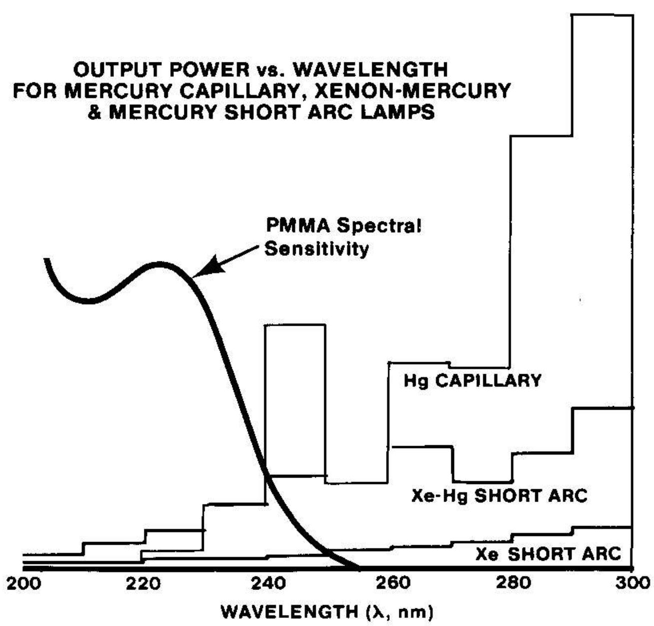

FIGURE 1

2) Hg (mercury): high-pressure, short arc lamps produce line radiation in the 200 to 315nm range. However, significant levels of energy are produced only at the 254nm line and around 300nm. This source has very limited use in other than the 285-315nm range. Super high-pressure Hg lamps (capillary types) can produce radiation at the shorter wavelengths; however, they perform best in the mid-UV range between 250 – 315nm (see Figure 1).

3) Xe-Hg (xenon-mercury): high-pressure, short arc lamps produce essentially a line structure on a low-level continuum from 210 to 315nm. Available in powers from 350W to 2000W, the Xe-Hg lamp is the best source currently used for most DUV applications (see Figure 1).

4) Pulsed Mercury: high-pressure, short arc lamps driven from idling power to high intensities with short, high-energy pulses. This source appears to have great potential as it displays a strong continuum in the 200 to 300nm range when hit by these short, high-energy pulses. However, it suffers significant inconsistancies such as lacking repeatability and short life. Practical use is highly questionable.

5) Pulsed Sources (e.g. Xenon): low-medium pressure, long arc flash lamps driven by very short, high-energy pulses. This source delivers a continuum rich in content from 200 to 315nm. In fact, about 6% of the total emission is between 200 and 260nm. Most appealing of all, this source produces a repeatable continuum of short wavelengths while maintaining acceptable lamp life.

6) Doped Sources: past efforts have been made to enhance selected spectral emissions by doping lamp materials during their manufacture. Originally promising, practical results have been less than successful. Since most dopants are in salt form, it is difficult to get them to stay vaporized. Doped lamps are hard to build and tend to be inconsistent in output with short life spans. Nevertheless, several manufacturers are continuing development.

7) Lasers: some Eximer types emit radiation in the deep UV. Krypton-fluoride produces an emision line at 222nm. These lasers have not yet achieved the higher power levels needed to make them useful except for R&D purposes.

There are three sources which have the potential to be used for multi-level applications. These are Xenon-Mercury, low-pressure Cadmium, and pulsed Xenon.