

PHASE-SHIFTING LITHOGRAPHIC MASKS HAVING PHASE-SHIFTING LAYERS OF DIFFERING COMPOSITIONS

Abstract

A phase-shifting lithographic mask (500 or 600), for use in conjunction
5 with optical radiation of wavelength λ , has a transparent substrate (10) upon which
are successively located a bottom $(2m+1)\pi$ radian phase-shifting layer (11) and a
patterned top $(2n+1)\pi$ radian phase-shifting layer (12) each having at least
approximately the same refractive index at the wavelength λ as that of the substrate.
A more finely patterned, opaque chromium layer (13) is located on the patterned top
10 phase-shifting layer. The bottom phase-shifting layer is chemically different from
both the substrate and the top layer, in order to provide either etch-stopping or end-
point etch detection during subsequent dry ion beam millings--as with gallium
ions--of either or both of the layers, for the purpose of mask repair. For example, the
substrate is quartz (silicon dioxide), the bottom phase-shifting layer is calcium
15 fluoride, and the top phase-shifting layer is silicon dioxide. Remnants of the gallium
then can be removed, if need be, from both the exposed portions of the substrate and
of the bottom layer--such as by forming indentation regions (52; 51) by means of
successive etchings, for example, with HF and HCl, respectively, for respective
prescribed time intervals having a ratio such that the relative phase shifts of the
20 substrate and both phase-shifting layers are not disturbed by the respective etchings.

This Sheet Has Been Replaced

