photomask pattern, embodiments of the invention seek to provide a photomask blank which may satisfy both high resolution and a high accuracy of etching when the photomask blank is processed into the photomask, and more specifically, a photomask blank which is low in the optical proximity effect of a photomask pattern during etching and may ensure a sufficient accuracy of processing; a method for preparing the blank; and a photomask having a mask pattern of the film on the photomask blank.

Regarding a photomask blank comprising an etching stop film, a light-shielding film, and an etching mask film on a transparent substrate, the inventors have found that better results are obtained when the etching stop film is a film of multilayer structure including a first layer disposed contiguous to the substrate and functioning as an antireflective layer on the substrate side and a second layer functioning as a fluorine-base dry etching-resistant layer, wherein one of the first and second layers is a layer having compressive stress induced therein and the other is a layer having tensile stress induced therein. The reflectance on the substrate side at the exposure wavelength may be reduced. The pattern transfer performance upon exposure through the photomask may be satisfactory. The warpage caused by the etching stop film may be minimized. The relief of stress in the etching stop film during formation of a mask pattern of the photomask may be reduced. Thus, the strain in the photomask pattern may be minimized.

In one aspect, the invention provides a photomask blank from which is produced a photomask comprising a transparent substrate and a mask pattern formed thereon including transparent regions and effectively opaque regions to exposure light, the photomask blank comprising an etching stop film disposed contiguous to the substrate and consisting

regions to exposure light, the mask pattern comprising an etching stop film of multiple layers formed of a material which is resistant to fluorine-base dry etching and removable by oxygen-containing chlorine-base dry etching, and a light-shielding film which is disposed contiguous to the etching stop film and consists of a single layer of a silicon-containing material or multiple layers including at least one layer of a silicon-containing material, the silicon-containing material being resistant to oxygen-containing chlorine-base dry etching and removable by fluorine-base dry etching. The photomask on the substrate side has a reflectance of up to 35% with respect to the exposure light. The etching stop film includes a first layer which is disposed contiguous to the substrate and functions as an antireflective layer on the substrate side and a second layer functioning as a layer highly resistant to fluorine-base dry etching, one of the first and second layers is a layer having compressive stress induced therein and the other is a layer having tensile stress induced therein.

ADVANTAGEOUS EFFECTS OF INVENTION

The photomask blank of the invention having an etching stop film having low film stress is processed into a photomask. Upon exposure through the photomask, satisfactory transfer performance may be obtained while reflection on the substrate side may be restrained. After a mask pattern of the photomask is formed, the relief of stress in the etching stop film may be minimized. The photomask pattern can be formed at a high accuracy. The photomask obtained by processing the photomask blank may be improved in reliability on its use in sub-20 nm node lithography.

BRIEF DESCRIPTION OF DRAWINGS