manufactured by Lasertec), and the transmittance rate was 5.9% and the phase difference was 175.9 degrees.

[0058]

Next, the transparent substrate 1 having the phase shift film 2 formed thereon was placed in a single-wafer DC sputtering apparatus, and reactive sputtering (DC sputtering) was carried out using a chromium (Cr) target under a mixed gas environment of argon (Ar), carbon dioxide (CO_2), and helium (He). Thus, an absorber film (CrOC film Cr:O:C=55atom%:30atom%:15atom%) 3 formed of chromium, oxygen, and carbon was formed at a film thickness of 43nm in contact with the phase shift film 2.

[0059]

Next, the transparent substrate 1 having the absorber film (CrOC film) 3 formed thereon was subjected to heat treatment. Concretely, the heat treatment was carried out using a hot plate at a heating temperature of 280°C in the atmosphere for five minutes. After the heat treatment, a spectrophotometer (Cary4000 manufactured by Agilent Technologies) was used on the transparent substrate 1 having the phase shift film 2 and the absorber film 3 stacked thereon to measure an optical density of the stacked structure of the phase shift film 2 and the absorber film 3 to ArF excimer laser light wavelength (about 193nm), confirming the value of 3.0 or more.

[0060]

Next, the lower layer (SiON film Si:O:N=34atom%:60atom%:6atom%) 41 of the hard mask film 4 was formed at a thickness of 5.5nm on the absorber film 3. Concretely, the lower layer 41 was formed by placing the transparent substrate 1 having the phase shift film 2 and the absorber film 3 stacked thereon in a single-wafer DC sputtering apparatus, and by DC sputtering using a silicon (Si) target with argon (Ar) gas, oxygen (O_2) gas, and nitrogen (N_2) gas as sputtering gas.

[0061]

Next, the upper layer (TaBO film Ta:B:O=36atom%:8atom%:56atom%) 42 was formed at a thickness of 2nm on the lower layer 41. Concretely, the upper layer 42 was formed