

ABSTRACT

A projection optical system that has liquid interposed in an optical path to the image plane to achieve a large effective image-side numerical aperture larger than, for example, 1.4, while a relatively large effective imaging region can be achieved. The projection optical system that projects a reduced image of a first surface (R) onto a second surface (W). The optical path between the projection optical system and the second surface can be filled with liquid (Lm) having a refractive index larger than 1.5, where a refractive index of gas in an optical path within the projection optical system is 1. The projection optical system comprises a boundary lens (Lb) that can be contacted with the gas on the side of the first surface and contacted with the liquid on the side of the second surface, and the boundary lens has a positive refracting power and is made of an optical material having a refractive index larger than 1.8.