Wire grid polarizer basing on interband absorption in the deep ultra violet spectral range

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Abstract

Polarizers are essential optical elements, utilized in numerous optical applications. Such components can be realized as nano-optical wire grid polarizers (WGP). These are zero order gratings offering an anisotropic transmittance depending on the direction of the electric field vector of the incident light. Wire grid polarizers are superior to other polarizer concepts due to their large possible free aperture (up to several 100 mm) while being simultaneously extremely thin (about 0.5 mm). Furthermore, they offer very large acceptance angle, and integration in other optical elements as masks for lithography or imaging sensors is easily possible. This has already enabled many previously unprecedented optical devices. In future such applications will advance further into the deep ultraviolet region. Currently, wire grid polarizer are made of metals as aluminum. This, fundamentally, becomes inefficient at short wavelengths leading to a virtual application limit at about 250 nm.
In this contribution we propose wire grid polarizer basing on interband transitions in semiconductors to expand their application range. Interband transitions are linked to pronounced absorption. Therefrom, an effective damping of the undesired polarization direction can be achieved. Depending on the actual material, these transitions occur in the DUV wavelength range. This renders such materials as superior candidates for the fabrication of DUV wire grid polarizers. In addition to the material requirements, the structure parameters of such elements are crucial for the optical functionality. A purposeful optical performance necessitates periods smaller than 100 nm (see fig. 1), ridge heights of about 150 nm and fill factors of about 25%. We successfully demonstrate the fabrication process by exploiting very fast character projection electron beam lithography and a double patterning process. Thereby, large DUV wire grid polarizers with a size of 100mm x 100mm were fabricated. At a wavelength of 270 nm the measured extinction ratio of such elements is larger than 500 and the transmittance is above 40% (see fig 2). The application wavelength ranges from about 230 nm to 290 nm. In this contribution we will discuss both, design and fabrication aspects of these nano-optical wire grid polarizers.

Figures

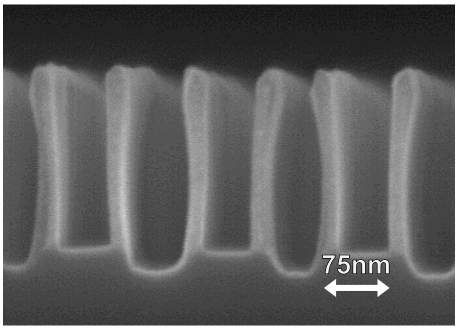

Fig. 1: SEM image of a fabricated DUV wire grid polarizer

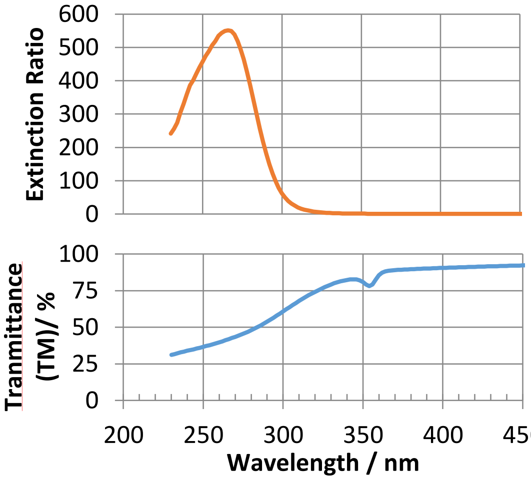

Fig. 2: Measured optical properties of a DUV wire grid polarizer basing on interband absorption