Highly reflective and robust Ag-Al compound mirrors on fused silica wafers

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In planar-integrated free-space optics signals may have to bounce up and down a considerable number of times inside the planar substrate to reach their destinations. To obtain a high coupling efficiency it is therefore mandatory to cover the optical elements with a highly reflective coating. Thin metal films are often used because they can conveniently be applied at low cost by means of physical vapor deposition.

Aluminum is well-suited for its chemical passivity and its good adherence to fused silica, however, it reflects less than 90% of the light in the 850 nm wavelength region. Silver, by contrast, has a high reflectivity of more than 99% but lacks the other two properties. So the idea is to use a compound coating that combines the advantages of both metals.

First the optical elements are fabricated on a fused silica wafer using lithography and dry etching. They are all surrounded by ditches of typically 1 µm width and depth. Then a thin layer of about 100 nm of silver is deposited first, followed by a layer of aluminum with a thickness of about 200 nm (Fig. 1). In this way the aluminum can mechanically anchor the mirrors in the ditches and shield the silver from aggressive chemicals in the environment. From the glass side the coating has the high reflectivity of silver.

For experimental characterization a sample mirror of this type was fabricated. In this sample the aluminum patch was made larger to be able to compare the performance of the two metals. The difference in reflectivity can already be perceived clearly with the naked eye or a CCD camera (Fig. 3). For a quantitative evaluation the setup of Fig. 2 was used. During the measurement the sample was shifted along the measurement path shown in Fig. 3.

Several recorded intensity values are plotted in Fig. 4. One can see three distinct levels as expected. About 7% of the incoming intensity was reflected at positions without any coating due to Fresnel reflections from the two glass surfaces. The silver part showed a reflectivity of about 98%, the aluminum part of just below 80% which is somewhat worse than expected. The mechanical stability was good and so far no degradation of the performance due to chemical reactions was observed.