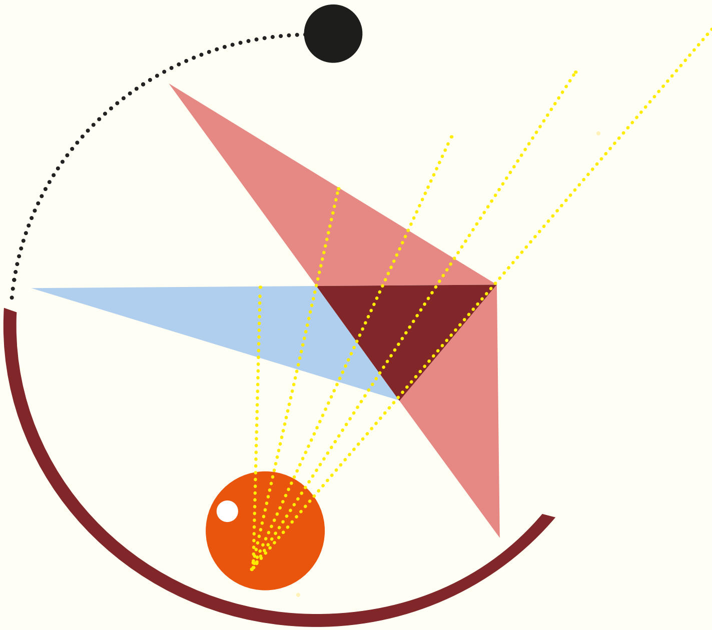
SPECTRUMA®



DMS

DEPTH

MEASURING

SYSTEM

IN SITU DEPTH MEASUREMENT DURING GDOES ANALYIS

Glow Discharge Optical Emission Spectrometry (GDOES) is a fast and reliable method for depth profile analysis. The measurable layer thicknesses range from 50 nm to 120 µm. Currently, the depth calculation is based on the concept of emission yield. With SPECTRUMA's new interferometric Depth Measuring System DMS, depth is measured directly during the analysis. The DMS can be installed in our standard glow discharge sources with anode diameters of 4 mm and 8 mm (Fig. 1). Existing units can be upgraded with little effort. Smaller diameters are in preparation.

FUNCTIONAL PRINCIPLE OF THE SPECTRUMA DMS

In contrast to classical interferometric methods such as the Michelson interferometer, the DMS uses the feedback interferometry or self mixing interferometry method. In this process, the light from a laser diode with integrated photo diode is focused into the centre of the focal spot via a lens system and a deflection mirror. From there, the light is reflected back to the laser diode along the same path. The material removal during the depth profile analysis increases the distance between the laser diode and the bottom of the focal spot. The change in distance leads to a change in the intensity of the laser diode. The laser diode emits coherent light. The sample reflects part of the light back into the resonator of the laser diode and interference occurs. This feedback affects the optical loss rate of the laser diode and a modulated component is added to the original intensity of the laser diode. The intensity of the laser diode with feedback can be described according to the equation:

$$I = I_0 - \kappa_{\text{ext}} \cos\left(\frac{4\pi L_{\text{ext}}}{\lambda}\right)$$

Where I is the intensity of the laser with feedback, I_0 the intensity of the laser without feedback, k_{ext} the feedback coefficient, L_{ext} the distance between the λ front facet of the laser diode and the sample, and the wavelength of the laser diode. The intensity of the laser diode is measured with the integrated photo diode. The material removal during the measurement increases the distance between the laser diode and the bottom of the focal spot. From the modulation of the intensity, the distance change L_{ext} between the bottom of the focal spot and the laser diode and thus the crater depth is determined. A distance change of the size of half a wavelength of the laser diode corresponds to a complete pass of the intensity modulation of the laser diode. The measurement takes place continuously during the sputtering process.

Fig. 1: DMS with standard glow discharge lamp

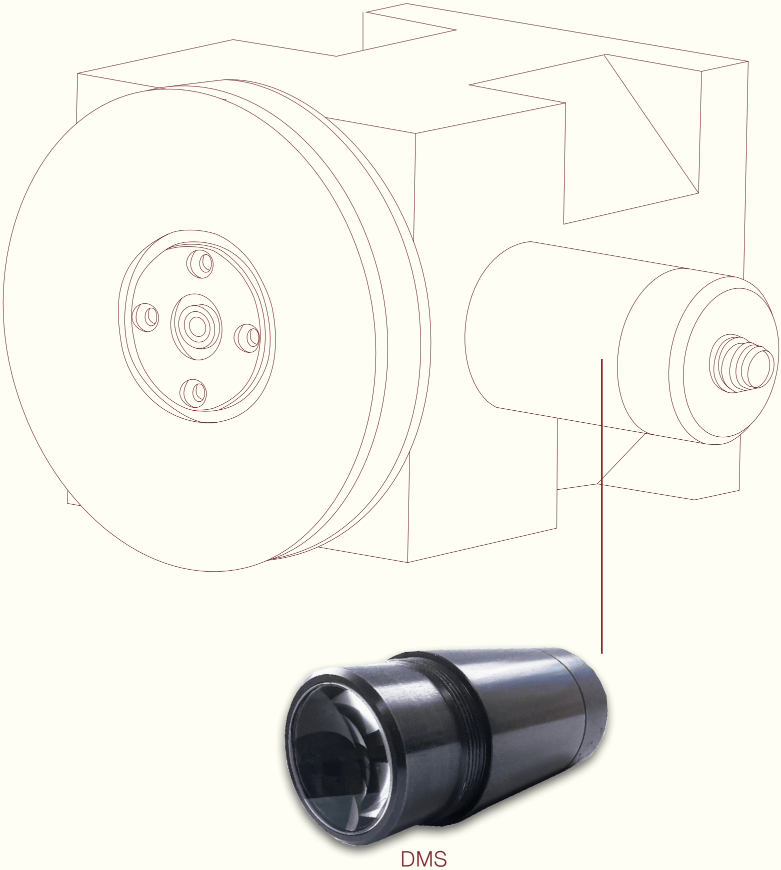
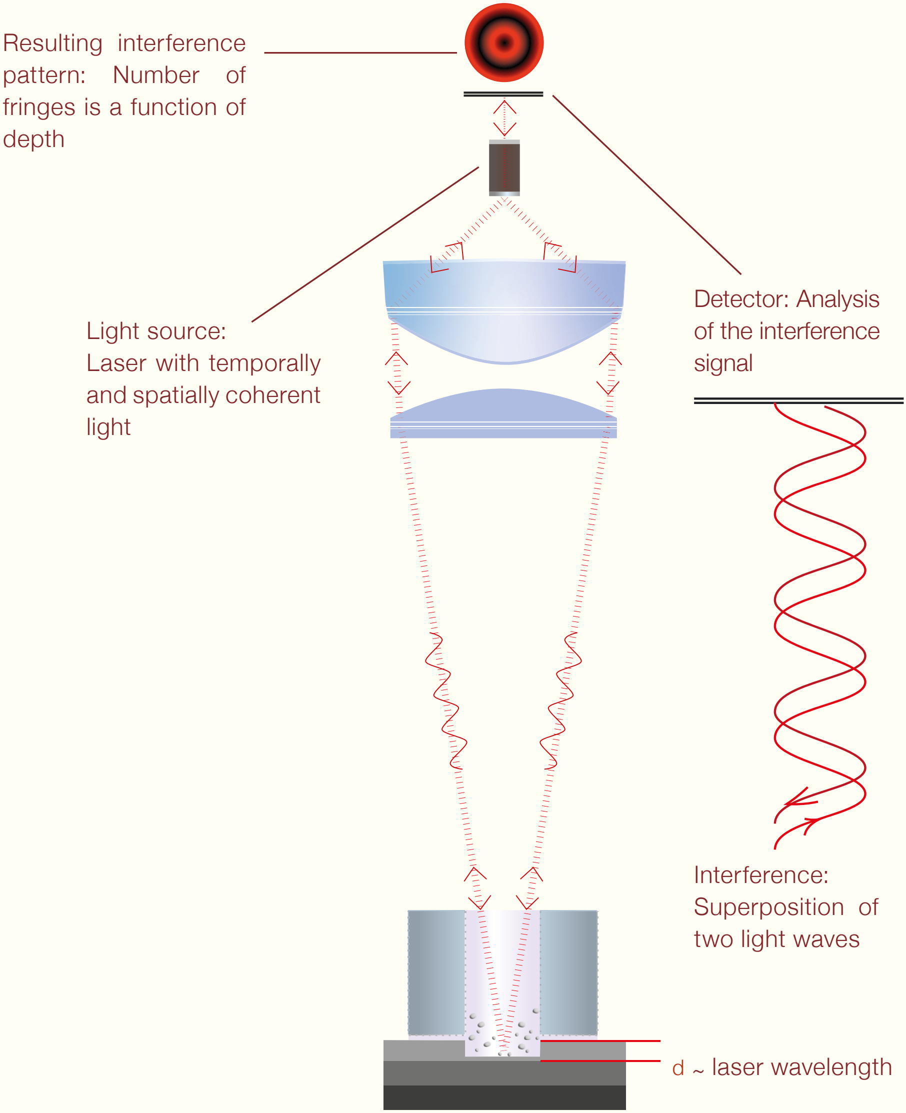


Fig. 2: Schematic illustration of the DMS



APPLICATION EXAMPLE OF THE SPECTRUMA DMS

The application example shows measurements on a galvanised steel sheet. The depth profile analysis shows the course of the intensities of zinc, aluminium and iron as a function of time (Fig. 3). In these measurements, a laser diode with a wavelength of 650 nm was used in the DMS. The intensity of the laser diode is measured during the measurement by means of the integrated photodiode (Fig. 4). The crater depth is calculated from the modulation of the intensity (Fig. 5). With the depth data of the DMS, the time axis can now be converted into a depth axis (Fig 6). The intensity axis can be quickly converted into a concentration axis via a suitable calibration and thus fully quantitative depth profiles can be determined very easily (Fig. 7).

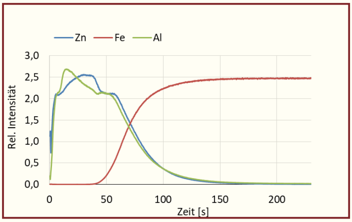


Fig. 3: Depth profile analysis on a galvanised steel sheet (intensity/ time graph).

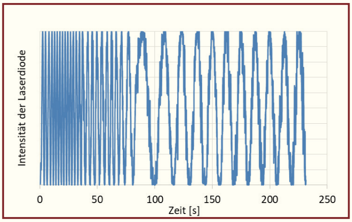


Fig. 4: Intensity of the laser diode measured with the integrated photo diode.

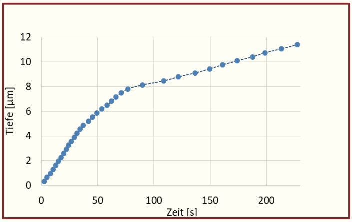


Fig. 5: Calculation of the depth from the modulation of the intensity of the laser diode.

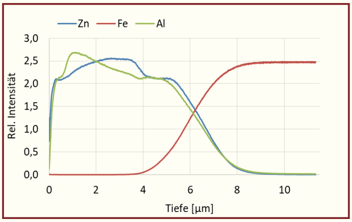


Fig. 6: Depth profile measured by the DMS.

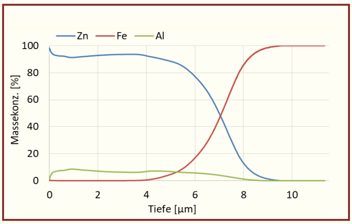


Fig. 7: Quantified depth profile (concentration/ depth graph)

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