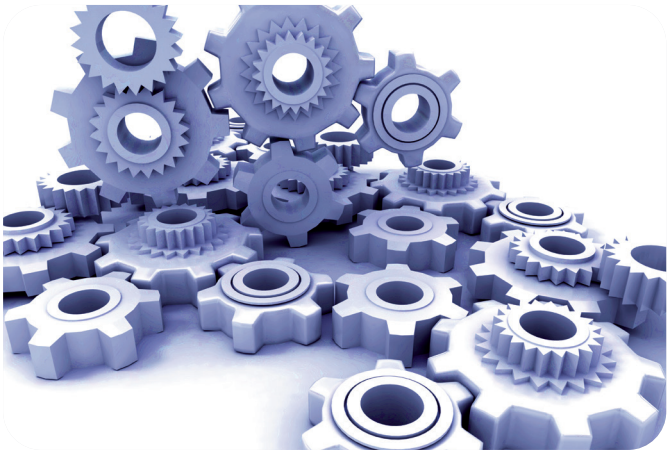

Application Note AN M90

Surface Analysis of Gear Wheels Using FTIR Spectroscopy

Surface coatings require absolute clean and dry work pieces devoid of remainders like fat, oil or salts. Only small amounts of these surface impurities will result in a poor adherence of the coating substance with all the negative impacts on the product quality. FTIR spectroscopy using diffuse and specular reflection provides a fast, easy and reliable solution for the detection of surface contaminations on metallic samples like gear wheels or metal sheets. With the aid of spectra libraries and automated search functions, it is also possible to identify the contamination. This information can be very helpful for the determination of suitable cleaning agents or the identification of possible causes of the impurities.

The Bruker ALPHA FTIR spectrometer in combination with the upward looking reflectance unit (fig. 1) is the ideal tool for routine surface-analysis for all kinds of metallic samples. The ALPHA is a very compact and robust spectrometer and therefore ideally suited for daily routine analysis.

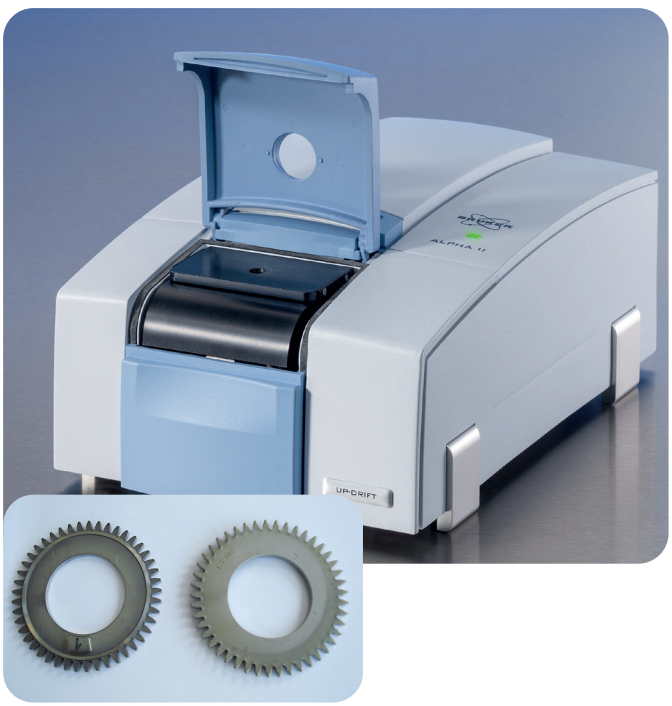

Figure 1: ALPHA spectrometer with the upward looking reflectance unit and the two different sides of a typical gear wheel (inset).

Surface analysis

In our example, we will try to answer two questions concerning the surface purity of gear wheels. The first question is whether the surface of the gear wheel is contaminated or not and the second question is which chemical identity a detected contamination has. The sample (shown in the

picture-inset of fig. 1) just needs to be placed on top of the measurement opening of the reflectance unit. The measurement takes just a few seconds and can be performed with the assistance of a specially designed software wizard guiding the user through the sampling and evaluation procedure.

Figure 2 shows the reflectance spectra of a thoroughly cleaned metal gear wheel measured on the outer (blue spectra) and inner (red spectra) face of the sample. In both cases,

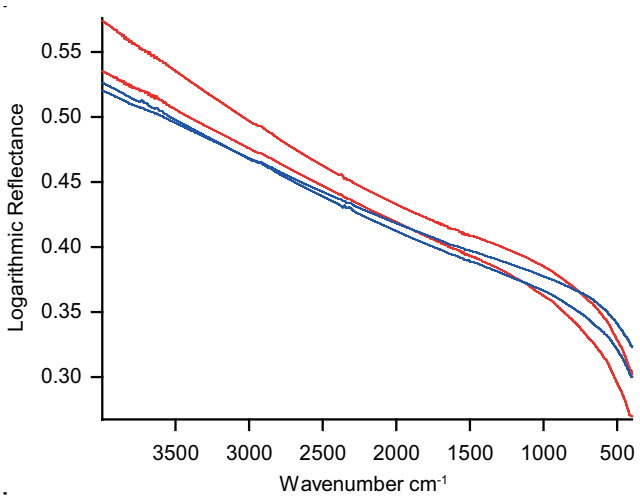

Figure 2: Spectra of a cleaned gear wheel measured on the outside (blue) and on the inside (red) on two different measurement spots in each case.

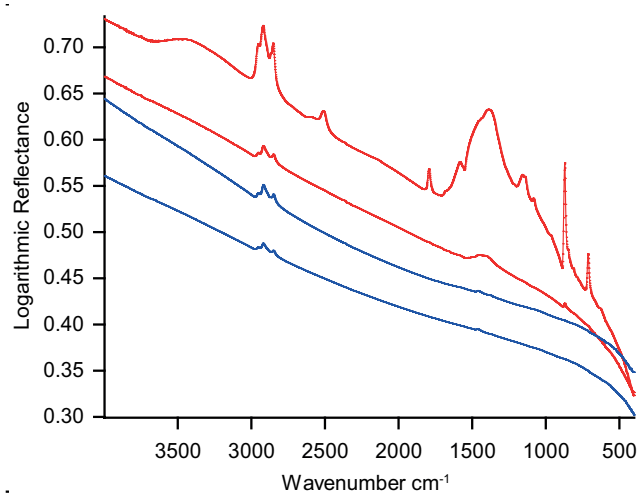

Figure 3: Spectra of a contaminated gear wheel measured on the outside (blue) and on the inside (red) on two different measurement spots in each case.

two spectra have been measured on opposing positions of the sample. As the spectra show no absorbance bands of any potential impurities they verify that the sample is perfectly clean.The slope of the flat base line reflects the roughness of the sample surface

In contrast, figure 3 is showing the reflectance spectra of an uncleaned sample. It is evident that the contamination is located mainly on the inner face of the sample but also the outside of the gear wheel shows weak absorption bands below 3000 cm^{-1} resulting from C-H vibrations.
To identify the chemical composition of the contamination an automated library search was performed. The result of this search is displayed in figure 4. The spectrum of the sample has been baseline corrected and is shown in red on top of the window. The spectra below are the first two hits of the library search. The green spectrum originates from a fat and the blue spectrum is indicating the presence of calcium carbonate (i.e. chalk). As can be seen the combination of the two library spectra explains almost all of the bands that are present in the sample spectrum. As a direct consequence, it is now very easy to select an appropriate cleaning agent since chalk can be easily removed with a mild acid and the fat is best treated with an organic fat-dissolving solvent like acetone or isopropanol.

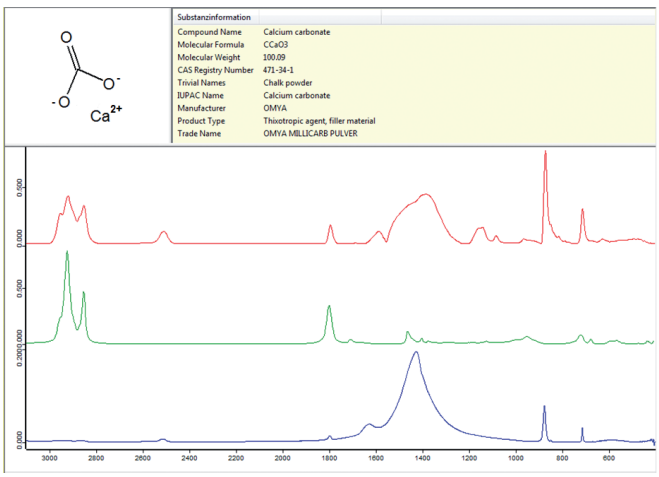

Figure 4: Search result of the library search with the sample spectrum on the top (red) and the identified contaminations fat (green) and calcium carbonate (blue) below.

In summary the Bruker Optics FTIR-spectrometer ALPHA with an upward looking reflection module offers a quick and robust measurement method for the determination of surface contaminations.

Bruker Scientific LLC
Billerica, MA · USA
Phone +1 (978) 439-9899
info.bopt.us@bruker.com

Bruker Optics GmbH & Co. KG
Ettlingen · Germany
Phone +49 (7243) 504-2000
info.bopt.de@bruker.com

Bruker Shanghai Ltd.
Shanghai · China
Tel.: +86 21 51720-890
info.bopt.cn@bruker.com

www.bruker.com/optics