COMBINING CONFOCAL RAMAN WITH ATOMIC FORCE MICROSCOPY FOR NANO-RESOLUTION IN MATERIAL ANALYSIS

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Raman spectroscopy is a well-established, nondestructive analysis technique that delivers detailed chemical information about the molecules involved in the scattering process.
Technical samples are very often heterogeneous and the distribution of the compounds is important. However, in most spectroscopy setups spatial resolution is poor, because the exciting laser spot diameter is on the order of 100µm. In this case, the sample properties are averaged over the size of the laser spot.

Optical microscopy, on the other hand, is capable of providing sub-µm spatial resolution.
By integrating a sensitive Raman spectrometer within a state-of-the-art microscope setup, Raman microscopy with a spatial resolution down to 200nm laterally and 500nm vertically can be achieved using visible light excitation.
Using the confocal arrangement, in which a pinhole is placed in the focal plane of the microscope to reject out-of-focus light, even depth profiling and 3-D imaging is possible if the sample is transparent. With this technique it is not only possible to obtain Raman spectra from extremely small sample volumes (down to 0,02µm^3), but also to collect high resolution Raman images.

In this work we present examples of Confocal Raman Microscopy from various fields of application, from pharmaceutical tablets to stress measurements in semiconductors. Please note that these examples are only a limited selection of the enormous variety of possible applications. Confocal Raman Microscopy can be useful when applied to all samples that are heterogenous on the µm to mm scale and that can in general be investigated by Raman spectroscopy.

By adding Atomic Force Microscopy (AFM) to the imaging capabilities, the optical diffraction limit can be overcome and a new dimension in lateral and topographical resolution is achieved. In AFM, the surface topography of a sample is probed with an extremely sharp tip at the end of a small cantilever, delivering nm precision in the lateral, and sub-nm resolution in the vertical dimension.
The topographical structures observed with the AFM can then be linked to and compared with the chemical information obtained by the Confocal Raman Microscope (CRM).

The advantage of combining these techniques in a single instrument is the possibility to switch between the different observation modes with negligible lateral shift. If two separate instruments have to be used, finding the same sample position again can be very time consuming, if not impossible without surface markers. In the CRM200, a special objective is available that allows the mounting of a cantilever to perform an AFM measurement with highest resolution. Switching between Confocal Raman and AFM is done by simply rotating the objective turret.