Application Data Sheet

Dispersive Raman Spectroscopy: Metal oxides

Thin layers

Metal oxides are used for a large variety of applications and can be deposited on a substance (substrate) with great accuracy from atomic thickness levels upwards. One highly sensitive method for following the deposition process of an oxide layer is Raman spectroscopy. Because Raman is sensitive to both the chemistry (atomic composition) and form (physical properties such as crystal-chemical structure, stresses, etc.) both the purity and quality of a coating can be assessed from a single and rapidly acquired spectrum.

The modern micro-focussing Raman spectrometer such as a JASCO NRS-1000 enables measurement from very small areas of sample, about one micron in size is typical. The combination of laser excitation and a sensitive, cooled CCD detector allows rapid analysis times of a few seconds per spectrum.

Both ex-situ measurement with the sample placed on the instrument's microscope stage and in-situ, with either a heating microscope attachment or an external fiber-optic probe, can be done. The following example shows Raman spectra from a catalysis sample of titanium oxide (TiO_2) having the anatase structure.

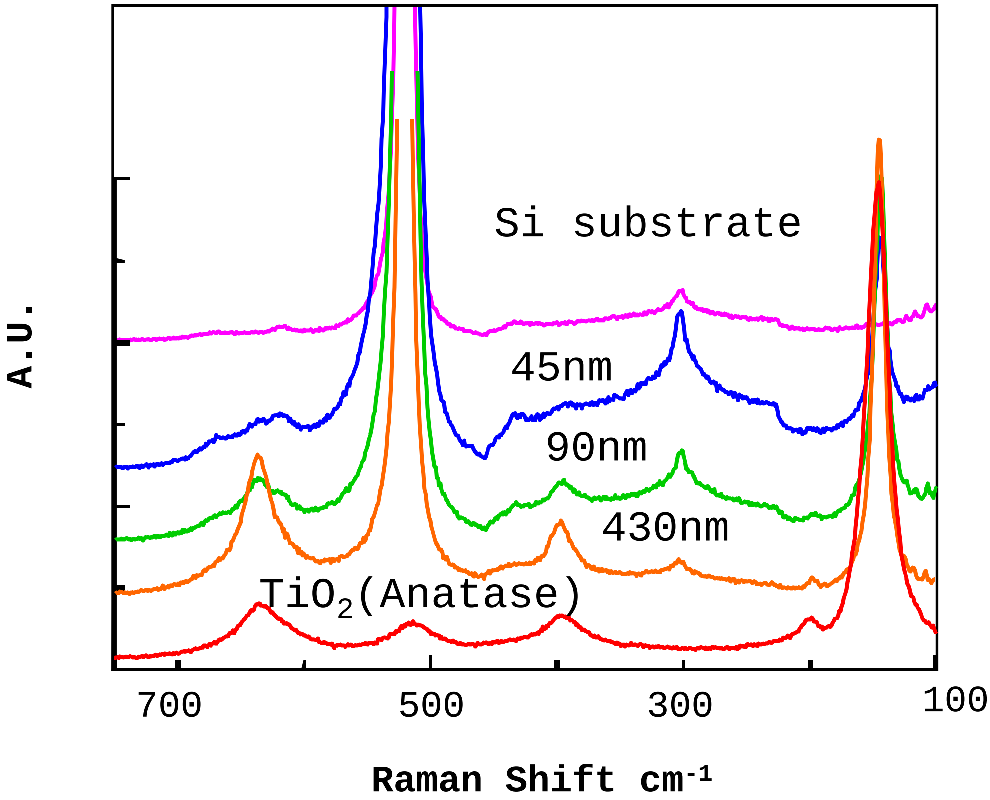


Figure 1. Composite of five separately acquired Raman spectra showing the differences between different thicknesses of anatase (TiO_2) deposited on a silicon substrate. Layer thicknesses range fom 45nm (blue spectrum) to 430nm (orange spectrum): the spectra from pure silicon and pure anatase are shown for reference (top and bottom spectra). Two peaks are of interest: the silicon peak at ~300 cm^{-1} (absent in the bottom anatase spectrum) and the anatase peak at ~150 cm^{-1} that increases in intensity with layer thickness.

Data Sheet: Metal oxides

By acquiring spectra from a number of points on an inhomogeneous sample and displaying the results as a composite "map", the distribution of a specific material at micron resolution can be determined. In the following example, one characteristic peak at 377 cm^{-1} from the mineral $MgSiO_3$ (perovskite) is used to map this oxide mineral's distribution.

Figure 2. Raman spectrum from $MgSiO_3$ perovskite.

The intense 377cm^{-1} peak was used to produce the 2-D mapping image shown below.

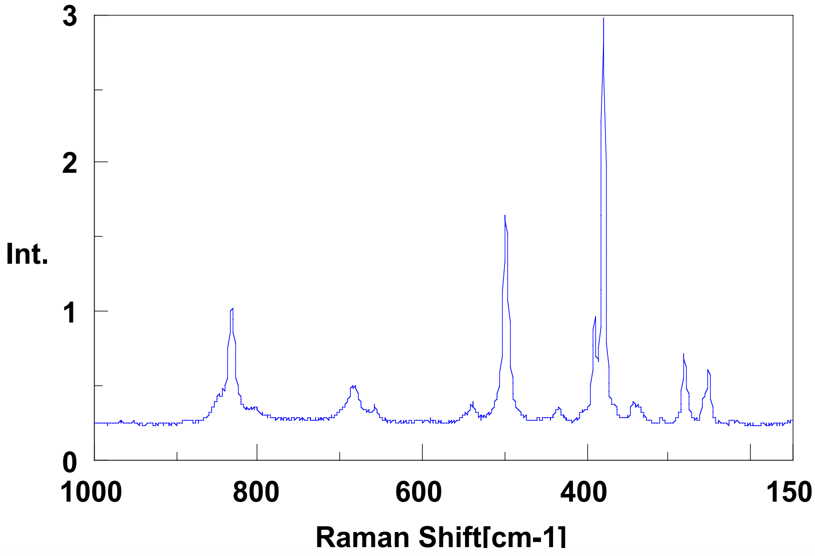
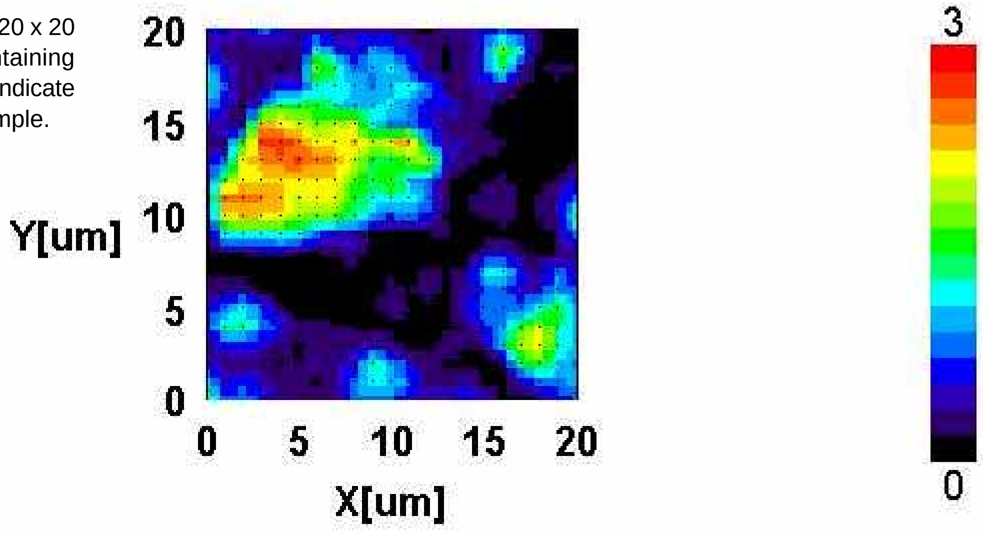


Figure 3. Spectral map from a 20 x 20 micron area of a sample containing $MgSiO_3$ perovskite. Red areas indicate perovskite-rich parts of the sample.



Instrumentation:

JASCO NRS-2100 micro-Raman spectrometer with green laser light (514.5nm, argon ion laser). A liquid-nitrogen cooled CCD detector was used.

JASCO INTERNATIONAL CO. LTD.

4-21, Sennin-cho 2-chome, Hachioji, Tokyo 193-0835, Japan Tel: +81-426-66-1322 Fax: +81-426-65-6512

On the Internet: http://www.jascoint.co.jp/english/index.htm **e-mail:** Div_1@jascoint.co.jp

JASCO INCORPORATED 8649 Commerce Drive, Easton, Maryland 21601-9903, U.S.A Tel:+1-800-333-5272 Tel:+1-410-822-1220 Fax:+1-410-822-7526

JASCO EUROPE s.r.l. Via Confalonieri 25, 22060 Cremella (Co), Italy Tel: +39-039-956439 Fax: +39-039-958642

JASCO Labor-und Datentechnik GmbH Deutschland (Germany) Tel: +49-6078-74949 Fax: +49-6078-74006

JASCO SpA (Italy) Tel: +39-039-957569 Fax: +39-039-958642

JASCO (UK) Ltd. (U. K.) Tel: +44-1371-876988 Fax: +44-1371-875597

JASCO Eastern Europe Information Office (Hungary) Tel: +36-1-4669549 Fax: +361-2093538

JASCO France s.a.r.l. (France) Tel: +33-2-40430043 Fax: +33-2-40432437

JASCO Benelux B.V. (Netherlands) Tel: +31-346-556699 Fax: +31-346-554619

JASCO Analitica Spain S.L. (Spain) Tel: +34-91-361-2440 Fax: +34-91-356-7058