

## Surface characterization in catalysis: An area of conflicting requirements

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inclusions are sometimes present which seem to have a different cooling history from the host chondrule itself. The sizes of these inclusions vary from 1 to 30  $\mu\text{m}$ . Three different micro-analytical instruments were used to investigate these glass inclusions in the Allende meteorite.

- 1) An electron microprobe to determine the low Z elements, present in a relatively high concentration.
- 2) A proton microprobe, to determine low concentrations of elements with  $Z > 19$ , using micro-PIXE.
- 3) A micro-Raman spectrometer, to investigate the presence and the ordering of carbon in the inclusions, because this element is particularly sensitive to the temperature of solidification.

From the measurements it was concluded that the glass inclusions did form after the crystallization of the chondrules out of a residual melt and not by recrystallization of part of the chondrules as shown by the different chemical composition. The abundance of carbon is not very well understood up to now, and we will investigate more meteorites to improve the data base available, in order to collect more evidence for the present cooling model.

#### SURFACE CHARACTERIZATION IN CATALYSIS: AN AREA OF CONFLICTING REQUIREMENTS

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During the last decade, experiments with single crystal surfaces in surface science have contributed to the view that the catalytic properties of a surface are determined by its local composition and structure. The ultimate goal of catalyst characterization should therefore be to study the surface composition and structure of a catalyst on the atomic scale. Because the state of a surface depends critically on the nature of the ambient atmosphere, a further requirement is that the characterization should be carried out under reaction conditions rather than in ultra high vacuum. The performance of a number of frequently used spectroscopies in catalysis are reviewed in the light of the requirements outlined above.

#### EXCHANGE OF ATOMS ACROSS ATOMICALLY SHARP INTERFACES

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The thermal stability of interfaces is of great importance for the design and application of multilayered structures. Here we report on the thermally activated site exchange between atoms across atomically sharp Ag/Au interfaces by using photoemission of adsorbed xenon (PAX). The model interface was formed by first preparing a monolayer of Au on a Ru(001) substrate, and then depositing at 60K a submonolayer quantity of Ag on top. Neither Au nor Ag penetrate the Ru substrate. PAX shows that upon annealing at 275 K, monoatomically thick Ag islands form on the Au. This structure constitutes the model interface. Exchange between Ag in the second and Au in the first layer on Ru starts at temperatures around 350 K, but occurs exclusively within the area of the Ag islands. The formation of a uniform Ag-Au alloy throughout both layers requires annealing temperatures as high as 760 K. The results can qualitatively be understood in terms of the lateral Ag-Ag and Au-Au interactions, the vertical Au-Ru and Ag-Ru interactions, the activation energies for surface and bulk diffusion and the heats of alloy formation between Ag and Au.

#### EDGE EFFECTS IN SEM AND SAM

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Two analytical techniques, the Scanning Electron Microscopy and the Scanning Auger Microscopy, depend on the same physical processes for their image formation. Both techniques are used to analyze problems in IC manufacturing. The SEM is used routinely to measure linewidths, contact hole sizes, etc. The SAM gives the chemical composition of these structures and their residues after