Motivation

- Analysis of the spectral response of various solvents in different stages of the semiconductor manufacturing process, for example, of any metal contamination in process liquids.
- Any contamination of these liquids reduces process yields.
- As defined by the ITRS, the maximum tolerable contaminant particle size varies roughly with the half pitch dimension of a given technology node.
- Early detection of contamination in the process liquids, rather than on the wafer after processing, allows for better yield.
- Particle detection in solutions with chemical specificity is a key to improving yield.
- Most reported solutions are not readily adaptable to monitor process liquid quality at the distributor and pump (i.e., at the process tools).
- Spectroscopic methods to identify contaminants in liquids in absent.
- Laser-based particle counting systems are expensive to use and typically known to a known upper limit cannot detect dissolved chemical contaminants.
- Optical spectroscopy techniques can be optimal choices to monitor and specifically nanomaterial size rather than their chemical nature.

Identifying Nanomaterials in Ultra Pure Water

Ultra Pure Water:

- Peaks from the vibrational modes of water are present in the 3000 cm⁻¹ region.
- Silica peaks dominate in the 4000 cm⁻¹ region.
- Standard peaks of water do not shift.

Alumina Oxide Samples:

- The modes associated with Al₂O₃ are located at 458 cm⁻¹, 561 cm⁻¹, 633 cm⁻¹, 714 cm⁻¹, and 783 cm⁻¹.
- The main peak at 367 cm⁻¹ is detected at 586.2 cm⁻¹. The majority of the peaks belong to silica in UPW.
- Al₂O₃ -30 nm -alpha

Aluminium Oxide - Different Structures

- The information presented in the table is presented in the literature.
- The obtained spectra include those from both the Cu-Au and the silica from which the fiber is made.
- Only one peak that is associated with Cu-Au detected at 586.2 cm⁻¹.
- The majority of the peaks belong to silica in UPW.

Copper Samples:

- Al₂O₃ -30 nm -alpha

Gamma and Alpha:

- The technique has also been used to investigate the Al₂O₃ nanoparticles in UPW. Contaminates such as Cu and Alumina have been investigated, where the Raman analysis has provided information about their chemical nature. Their respective Raman spectra were detected along with those from UPW.
- The chemical spectra by differentiating this technique provides both enhancement when compared to scattering-based particle detection (often used in the industry at present).
- The technique has also been used to investigate the Raman modes of Al₂O₃ nanoparticles with various toxic topologies. Clear distinctions in the Raman modes can be identified in both structures: Gamma and Alpha.
- The technique has also been used to investigate the Raman modes of Al₂O₃ nanoparticles with various toxic topologies. Clear distinctions in the Raman modes can be identified in both structures: Gamma and Alpha.

Similar phase but different size:

- The analysis of this work is to discover whether changes in nanoparticle size (Al₂O₃) can be detectable.
- For a single concentration and a single orientation, the size of Al₂O₃ nanoparticles has a significant impact on the Raman spectra.
- Therefore the difference in size definitely impacts the Raman spectra in two ways:

1. The similar vibrational modes present in both samples are shifted relative to one another.
2. There are vibrational modes that are unique and only present in one of the two samples but not common to both.

Summary

- Raman in solution is a promising technique to serve as an alternative to nanoparticle detection and monitoring in UPW.
- The technique has been used to investigate the Raman modes of various contaminants in UPW. Contaminates such as Cu and Alumina have been investigated, where the Raman analysis has provided information about their chemical nature. Their respective Raman spectra were detected along with those from UPW.
- The chemical spectra by differentiating this technique provides both enhancement when compared to scattering-based particle detection (often used in the industry at present).
- The technique has also been used to investigate the Raman modes of Al₂O₃ nanoparticles with various toxic topologies. Clear distinctions in the Raman modes can be identified in both structures: Gamma and Alpha.
- The technique has also been used to investigate the Raman modes of Al₂O₃ nanoparticles with various toxic topologies. Clear distinctions in the Raman modes can be identified in both structures: Gamma and Alpha.