15
P
Phosphorus
30.974

Towards Immobilising Phosphorus Catalysts on Silicon Surfaces

Silicon Chips as Environmentally Friendly, Highly Active and Selective Catalysts

| Matthew Farleigh*, 140216457, Chemistry MChem Honours, m.farleigh1@ncl.ac.uk |
| Supervisor: Dr Andrew Pike | Newcastle School of Chemistry |

14
Si
Silicon
28.0855

Introduction:

Catalysis is key to the sustainable use of scarce resources.

Catalysts are either homogeneous or heterogeneous, each type has its own advantages and disadvantages.

In this project, potential phosphorus based homogenous catalysts (ligands) were immobilised on silicon chips thus yielding a catalytic material which combines the properties and hence the advantages of both homogeneous and heterogeneous catalysts.

Aims:

- Show that it is possible to immobilise phosphorus based ligands upon silicon surfaces.
- Attempt to bind metal ions to the ligands which are immobilised on the surface.
- Research and utilise methodologies, allowing the measurement of changes in surface roughness (Fig 2) throughout the silicon chip functionalisation process (Fig 1).
- Determine whether changes in surface roughness (RA / nm) are due to covalent bonding between metal and ligand, or just physical deposition of material on the silicon surfaces (physisorption).

Results:

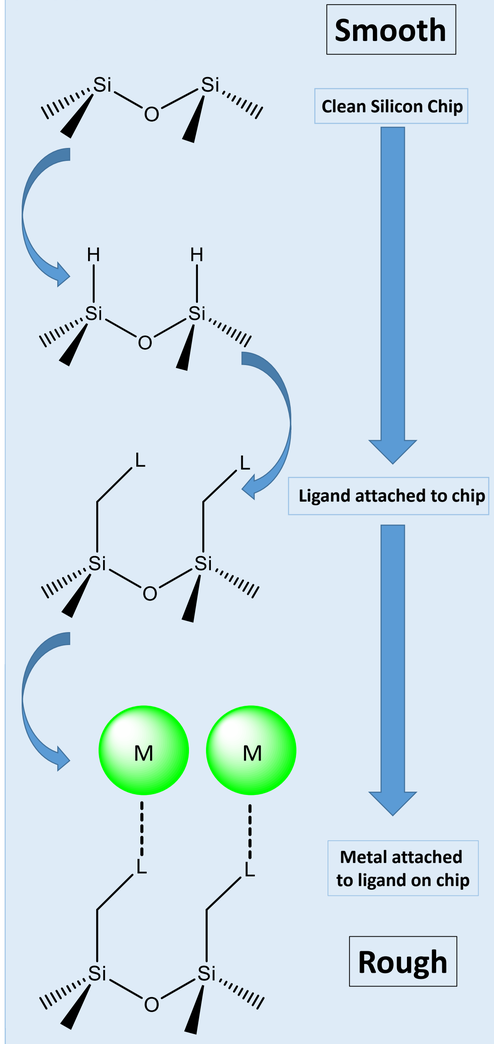
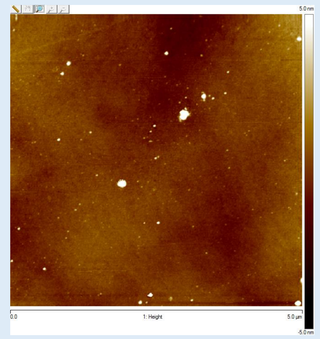
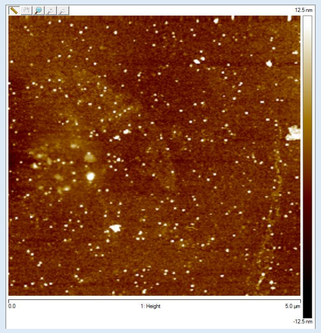


Fig 1: A schematic diagram to show the steps involved in attaching a catalyst to a silicon chip (functionalisation).





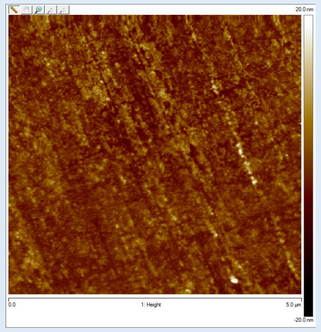


Fig 2: AFM images taken from the same silicon chip showing increasing surface roughness as the ligand and metal are attached

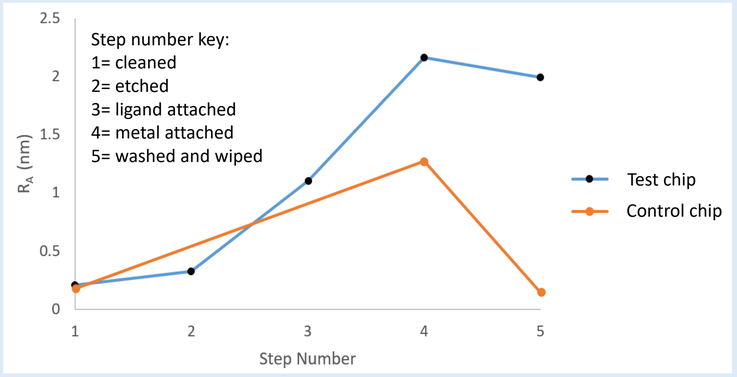


Fig 3: A graph to show how the roughness (R_A) of the surface of a treated silicon chip changes throughout the surface modification process relative to a chip which has not been treated with ligand.

Conclusions:

The increase in surface roughness was retained by the ligand treated chip after washing whereas the control chip became smooth again. This suggests that the ligand and metal have been successfully bound to the silicon surface and are not simply physisorbed.

The samples used to generate the data displayed in fig.3 have been sent off for X-Ray Photoelectron Spectroscopy analysis. This analytical method will help to reveal the elemental makeup of the surface thus enabling a better understanding of the nature of the silicon chips which have been produced.

In the future the catalytic activity of the chips will be tested and steps will be taken to optimise surface coverage of the chips by the ligand.

Newcastle University

LJH RESEARCH GROUP

CNL Chemical Nanoscience Laboratory

Further Reading:

M. Morita, T. Ohmi, E. Hasegawa, M. Kawakami, M. Ohwada, *Journal of Applied Physics*, 1990, **68**, 1272-1281