

PREPARATION AND CHARACTERIZATION OF SUPERHYDROPHILIC SILICA COATINGS AND THEIR APPLICATION AS ANTIFOGGING GLASS

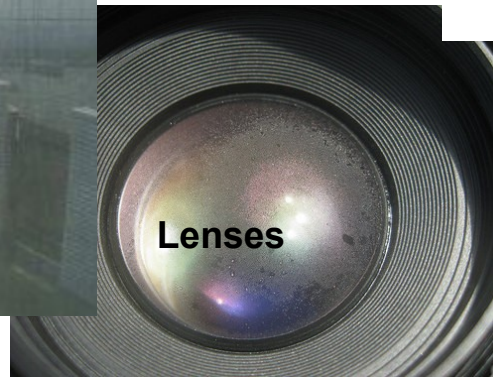
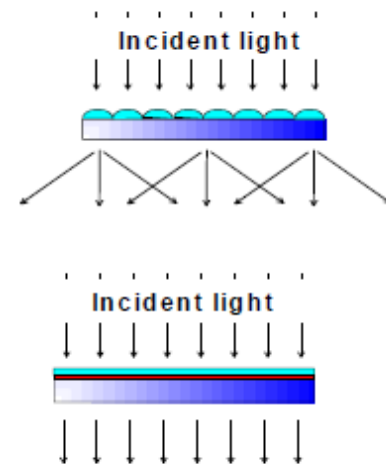
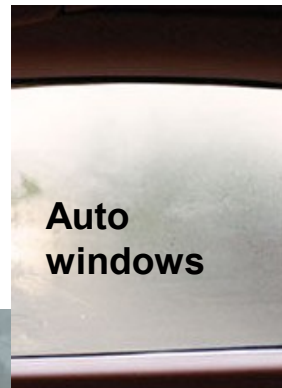
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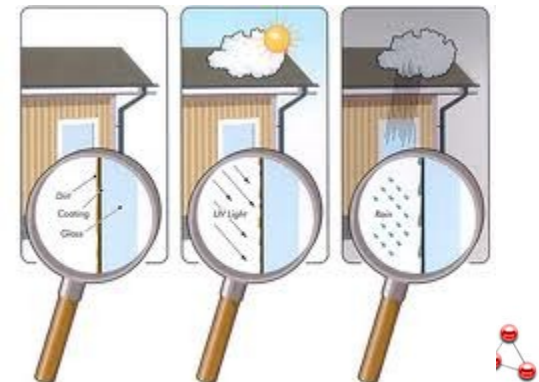
The trouble with fogging

- Fog forms when the temperature falls below (reach near) dew point
- Dew formation can be a localized effect, when air comes in contact with colder glass fogging can happen
- Droplets can scatter light, reducing the light transmission significantly, leading to low visibility



Antifogging coatings– History and strategies

- Antifogging glasses were first developed by NASA in project gemini
- The first commercial introduction by Pilkington Activ™
- Commonly used material is TiO_2 to impart both photocatalytic and UV induced superhydrophilicity
- Temporary, chemical coatings are commonly available in market

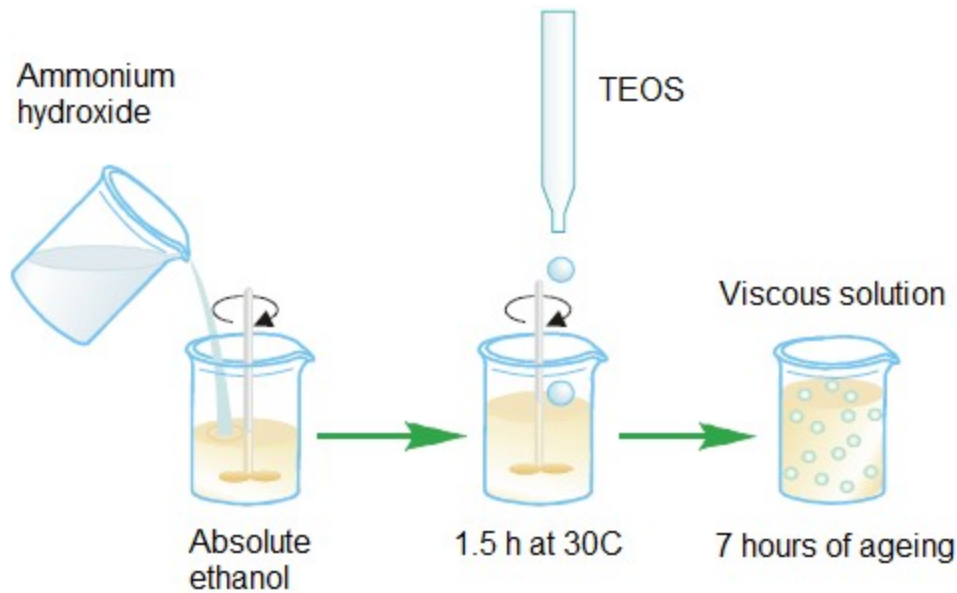


Objective of the research

- Preparation of stable superhydrophilic surface on glass for antifogging applications by facile method
- The coating should not alter the optical properties of glass
- Extended objective is to incorporate this property to IR reflective glasses

We used sol-gel coating route as a facile approach to make superhydrophilic glass coatings

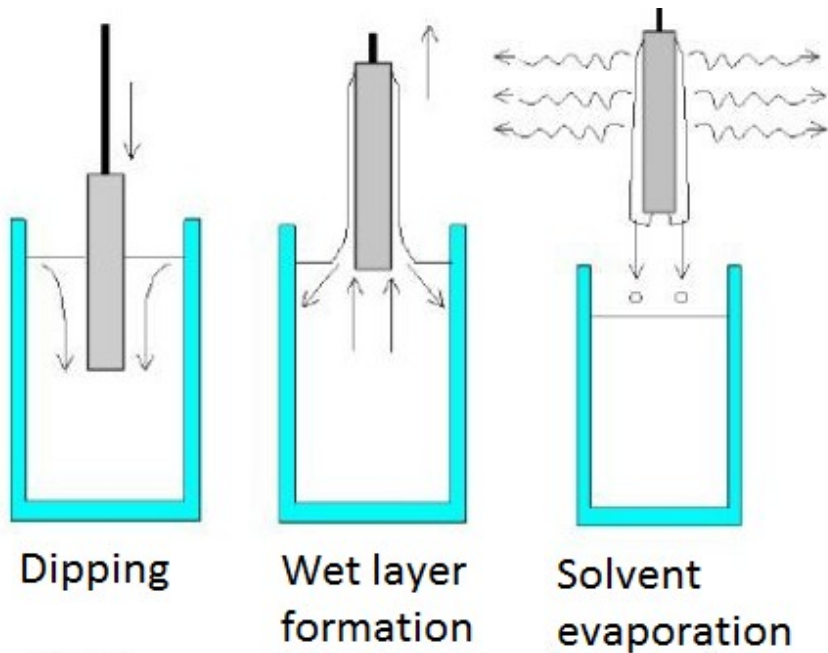
Preparation of coating solution



- Solution mixture of NH_3OH :ethanol=3/50, in volume was used as base solution
- TEOS (same volume as NH_3OH)was added to the solution dropwise over 1.5 h
- After sufficient ageing (7 h) solution become viscous which can be used to make the coating

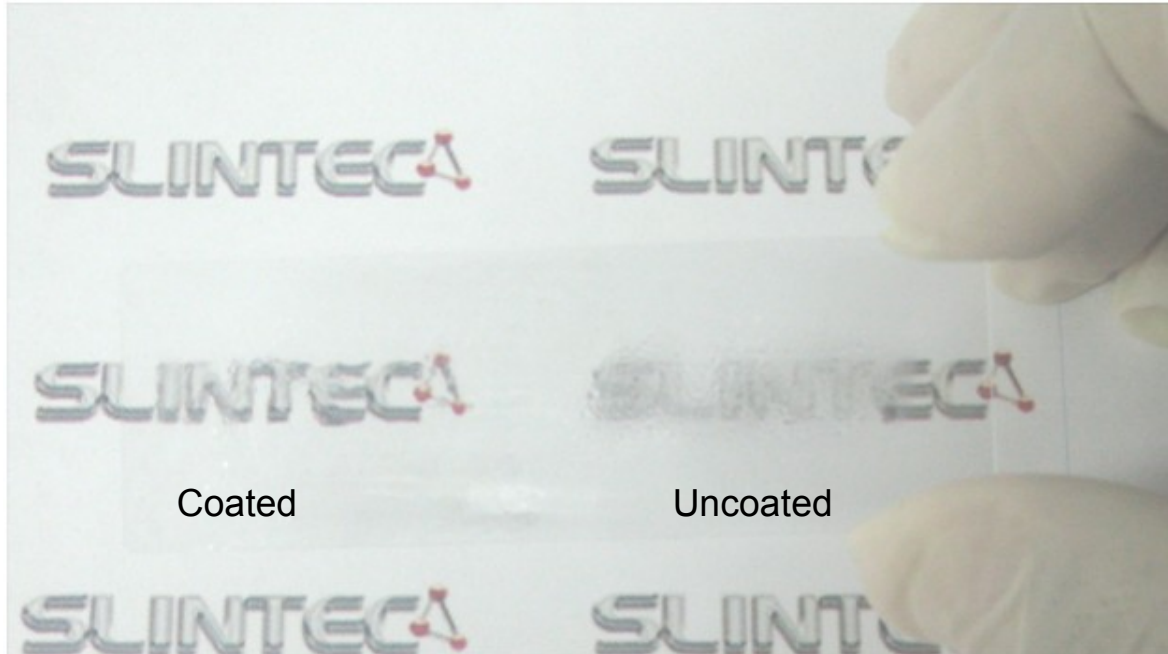
Stöber process

Coating preparation



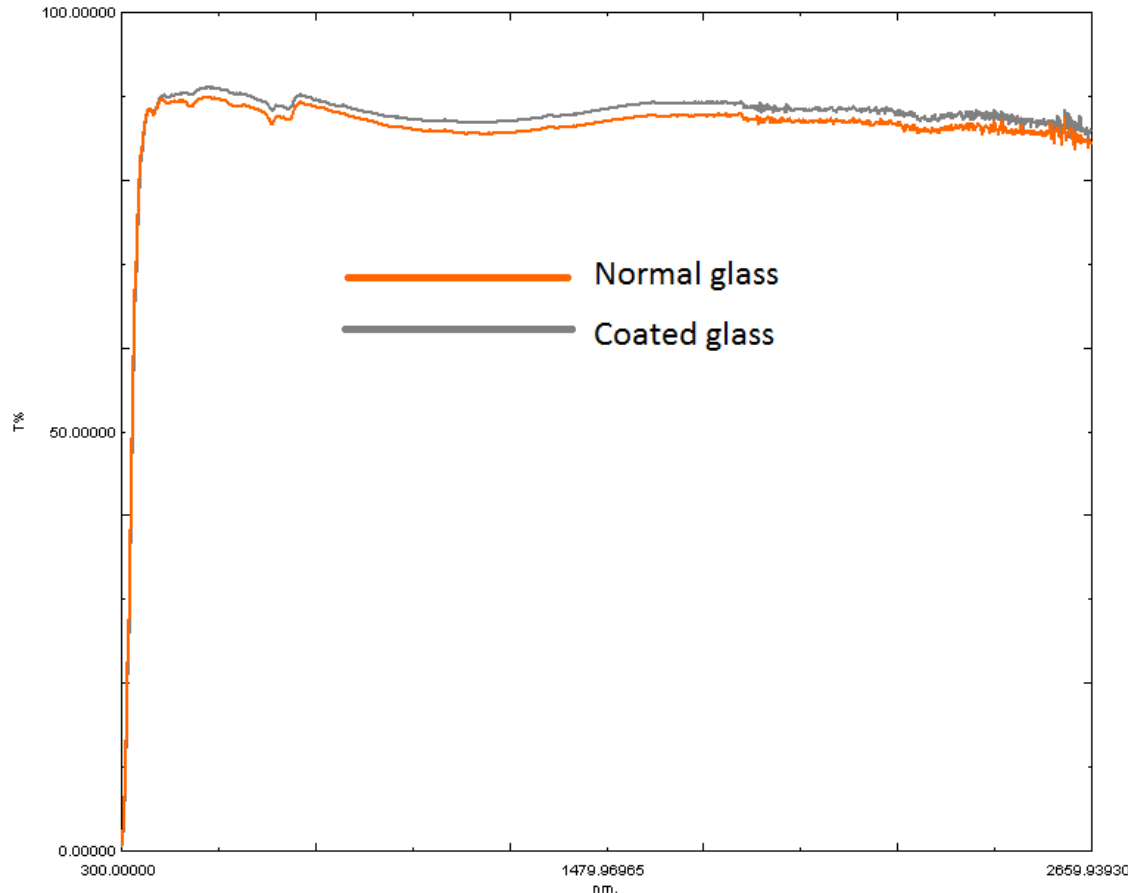
- Sol gel thin film was coated on glass using dip coating method (Dipping and withdrawal rate 3mm/s)
- Coating solution was dried at 60°C and fired at 300°C
- Superhydrophilic coatings with antifogging properties were formed once samples were UV exposed for 30 min

Fogging test



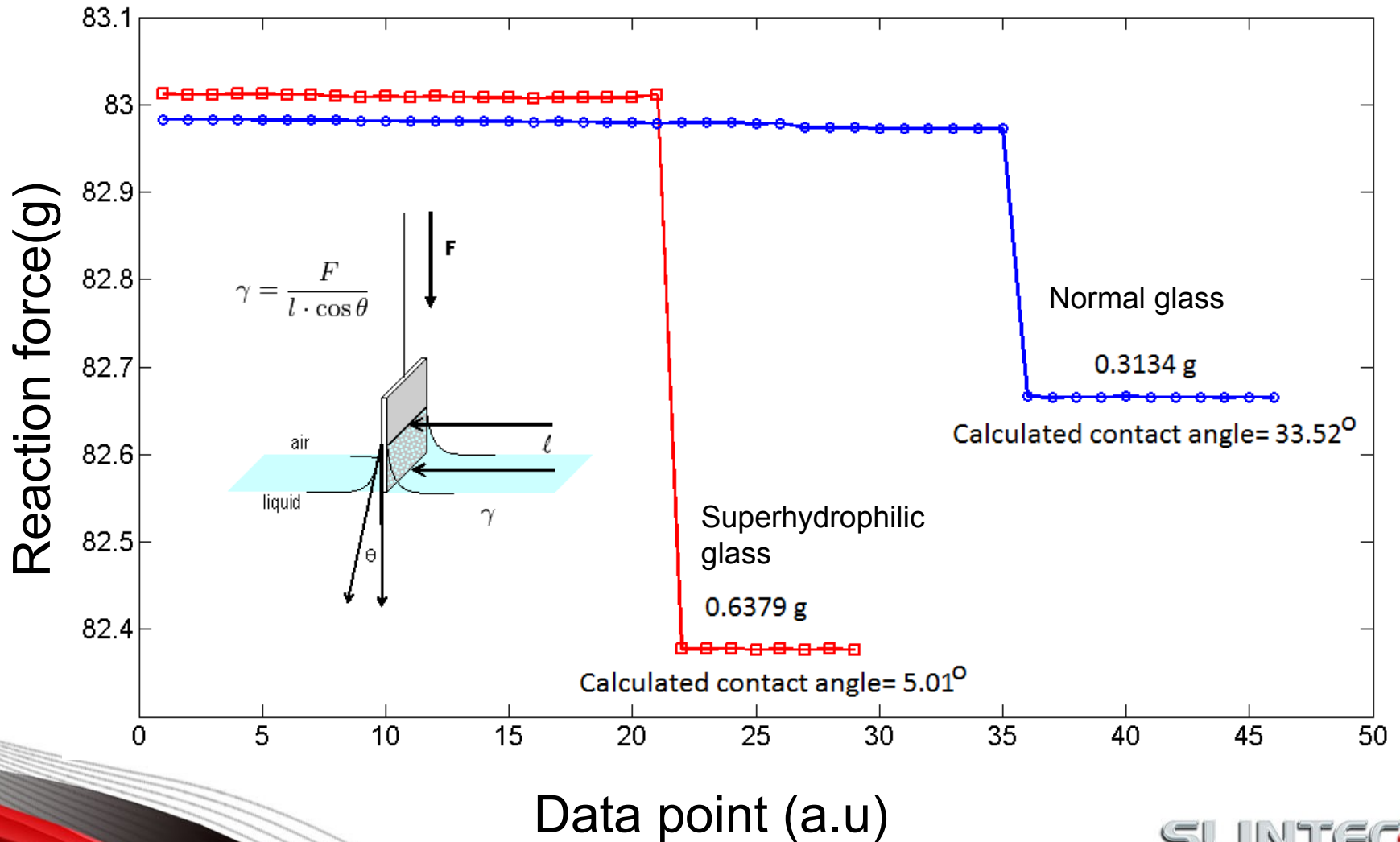
- antifogging was observed by cooling the half-coated glass slide in refrigerator at $-5\text{ }^{\circ}\text{C}$ for 20 min and then put the slide in humid air
- Another method was to place half coated glass side over a beaker containing hot water

Transmission of light

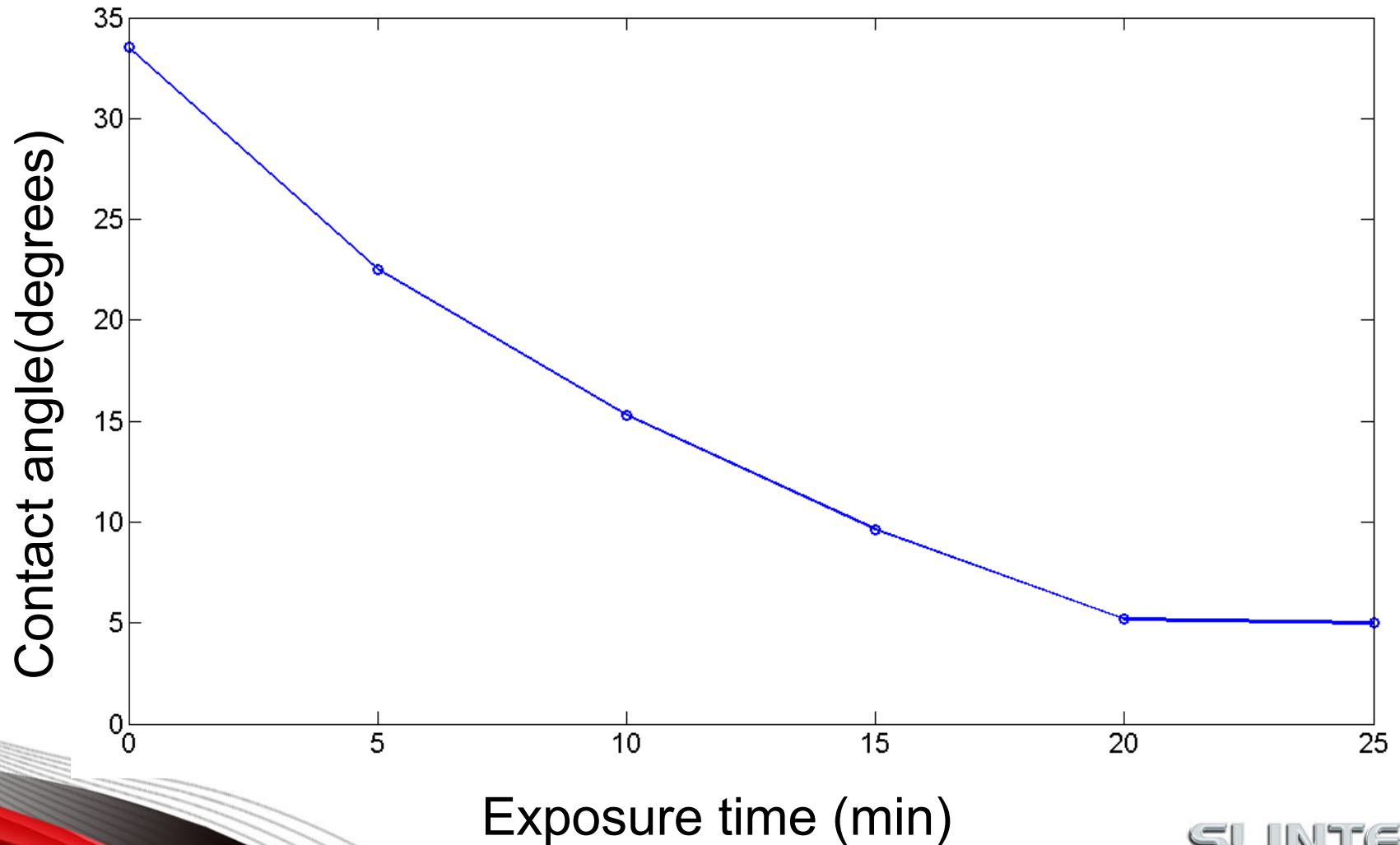


- Light transmission was similar to the glass over the tested UV, Vis, NIR wavelengths
- Slight antireflective property was also observed in some of the samples tested

Contact angle by Wilhelmy plate method

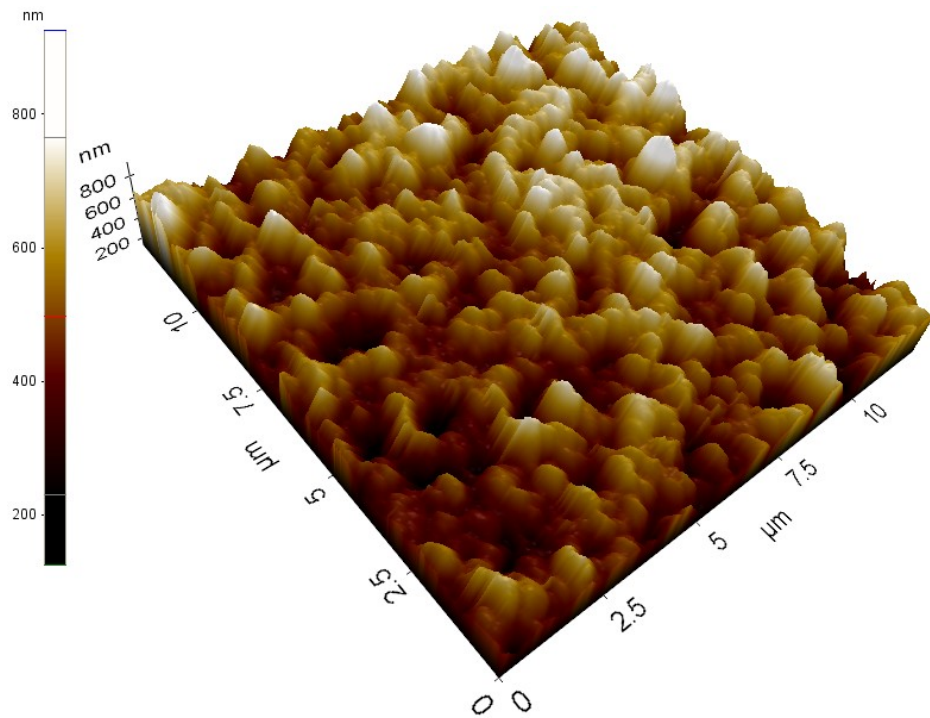


Reduction of contact angle with UV exposure time

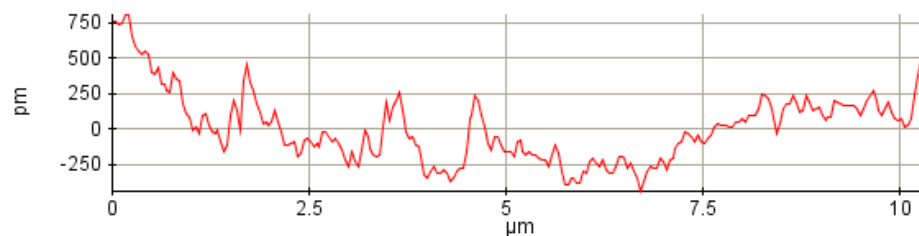
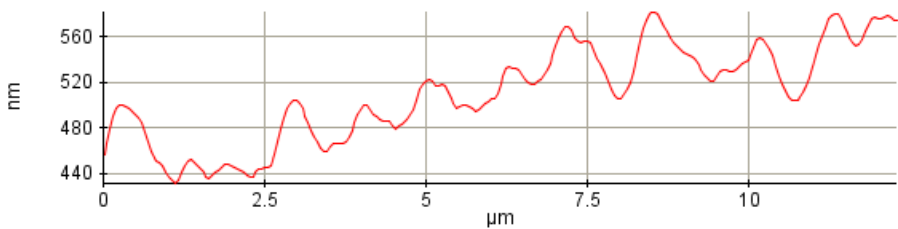
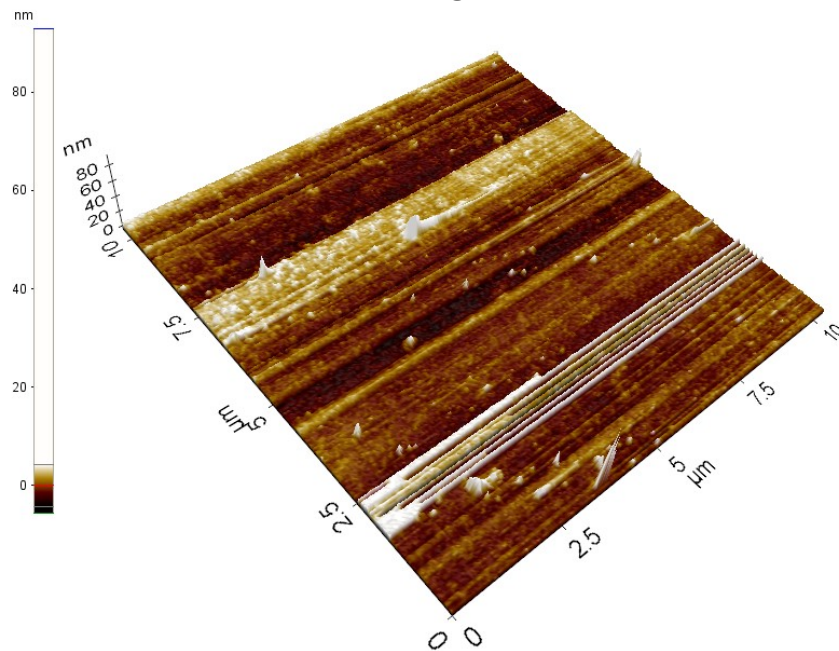


AFM analysis

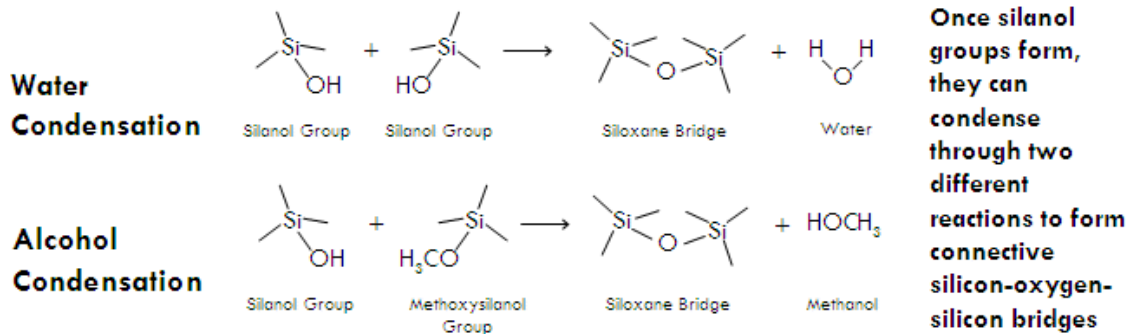
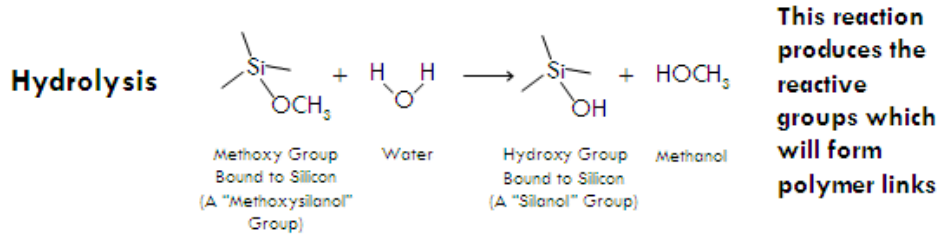
ITO coated glass



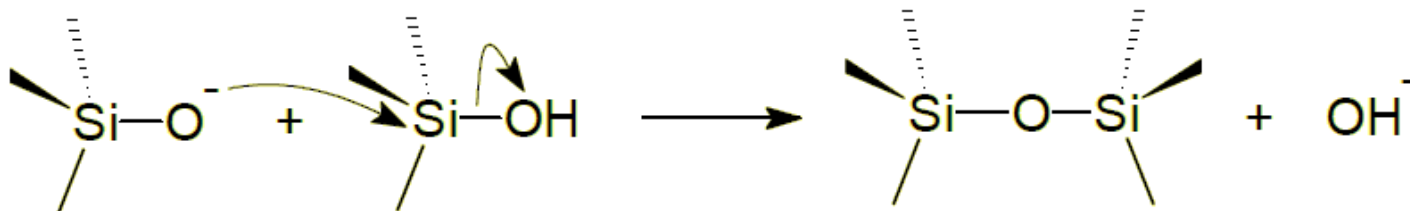
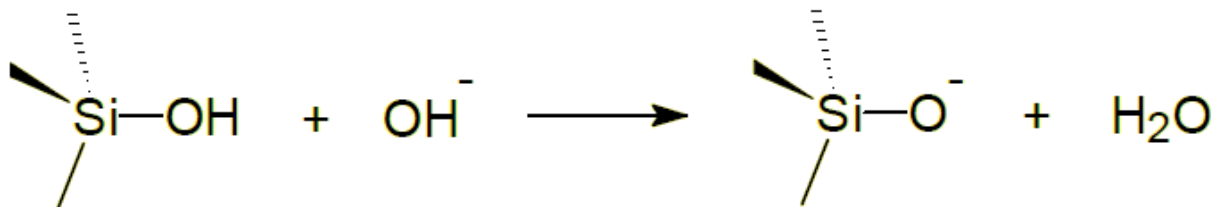
Uncoated glass



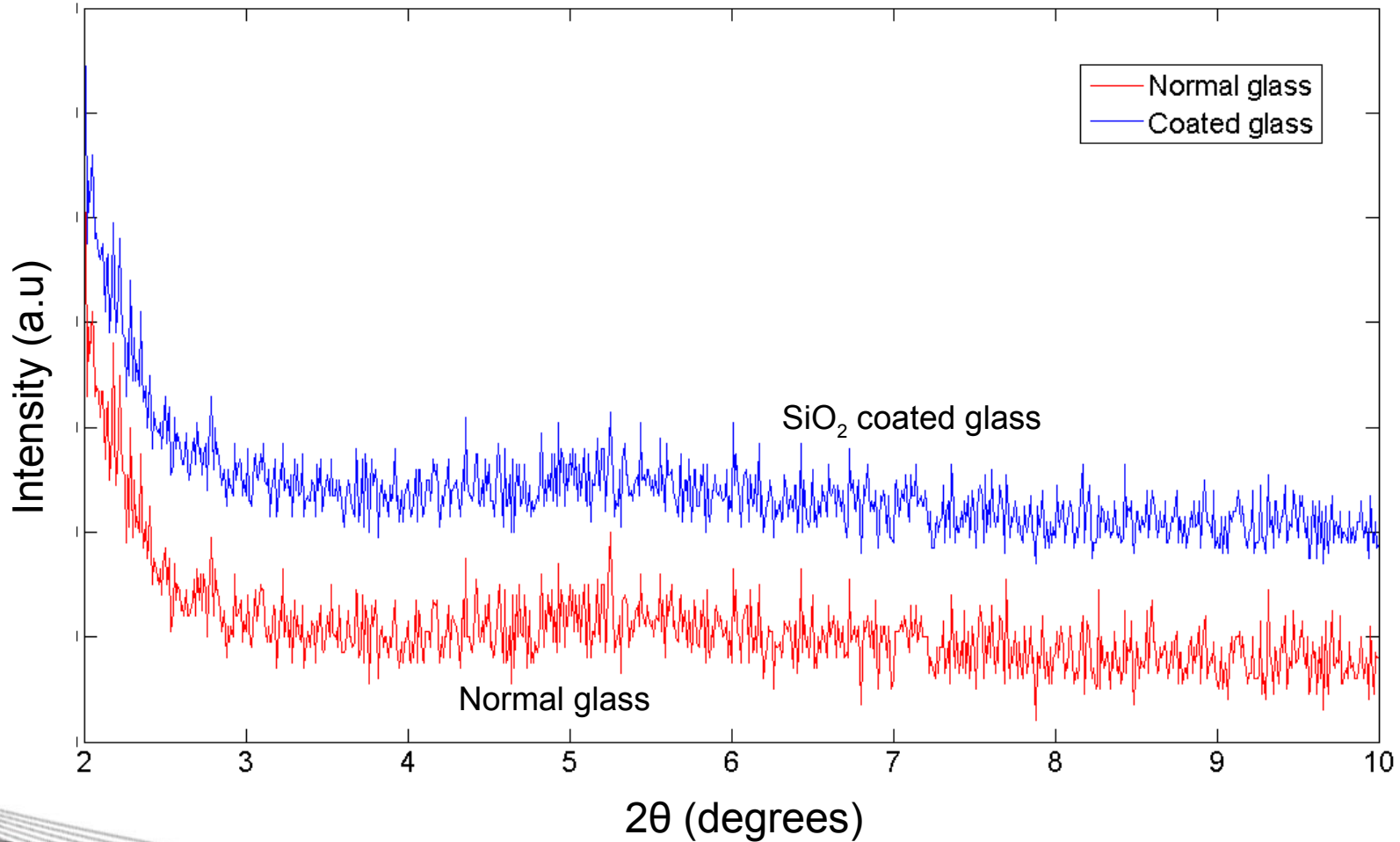
Base catalyzed Sol-gel preparation of silica



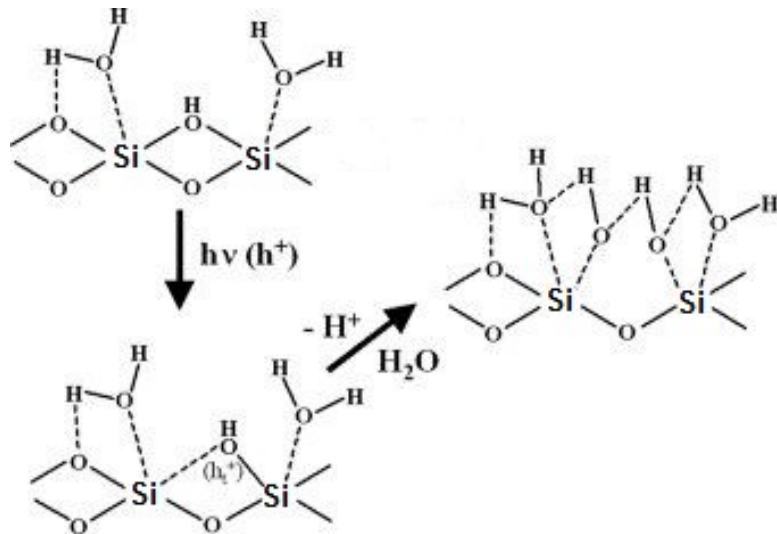
- Both hydroxyl ions as well as deprotonated silanol groups are better nucleophiles
- Rapid attack on silicon atoms can lead to hydrolysis and condensation to happen simultaneously
- The resulting polymer is highly branched which results spherical particles



XRD analysis (small angle x-ray diffraction)



Reason for superhydrophilicity



- Literature available that suggests, upon UV exposure, oxygen vacancies occur on the surface of the SiO₂
- Water molecules can then occupy these oxygen vacancies, producing adsorbed OH groups, which tend to make the surface hydrophilic
- Higher surface area with hydrophilic OH groups will produce superhydrophilic coating

Future work

- Further reduce the UV exposure time taken to reduction of contact angle
- Obtain the antireflective property along with the antifogging property
- Assess the mechanical hardness of the coatings
- Effect of firing temperature on antifogging property and surface evolution