

# COMPARATIVE STUDY OF THE HYDROPHOBIC PROPERTIES OF SILICA NANOPARTICLES FUNCTIONALIZED WITH DIFFERENT AGENTS

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## SCOPE

- In this research is presented a comparative study of the hydrophobic properties of silica nanoparticles functionalized with different agents.
- Spherical silica nanoparticles were synthesized by a sol-gel process and the modification of their surface was performed by a functionalization process with different silanes (hexamethyldisilazane - HMDS and 1H,1H,2H,2H-perfluorooctyltriethoxysilane - PFOTS).
- The hydrophobic properties were evaluated by measuring the water contact angle.

## EXPERIMENTAL

- ❑ **Synthesis of silica nanoparticles.** The synthesis of silica nanoparticles was made by chemical Stöber method, using a mixture of ethanol, NH<sub>4</sub>OH and H<sub>2</sub>O, homogenized through magnetic stirring and heated at 30°C, after that were drop wise added tetraethyl orthosilicate. The mixture was then gellified at 80°C and the resulted powder was dried at 120°C for 24 hours. A white powder, containing silica nanoparticles, was obtained.
- ❑ **Functionalization of silica nanoparticles with HMDS.** Silica nanoparticles mixed with toluene were placed in a three-necked glass flask. The mixture was stirred magnetically at 500 rpm for 1 hour. Thereafter, a 10% solution of HMDS in toluene was added and refluxed at 110°C for 6 hours. The solution is allowed to cool to room temperature and centrifuged at 4000 rpm for 30 minutes. The separated solid was redispersed in toluene and centrifuged again. The final product was washed with acetone. The nanoparticles thus prepared were dried at 150°C for 2 hours.
- ❑ **Functionalization of silica nanoparticles with PFOTS.** For the functionalization process, silica nanoparticles were dispersed by sonication at room temperature in a solution of ethanol:deionized water 9:1 v/v. During the sonication, was adjusted the solution pH, adding HCl 1N. On the mixture was then added PFOTS, the resulted solution being stirred at temperature of 80°C, for minimum 12 hours. The PFOTS-type silane functionalized silica (SiO<sub>2</sub>@PFOTS) were finally washed with ethanol and dried in vacuum (50 mbar) at 40°C.

## RESULTS

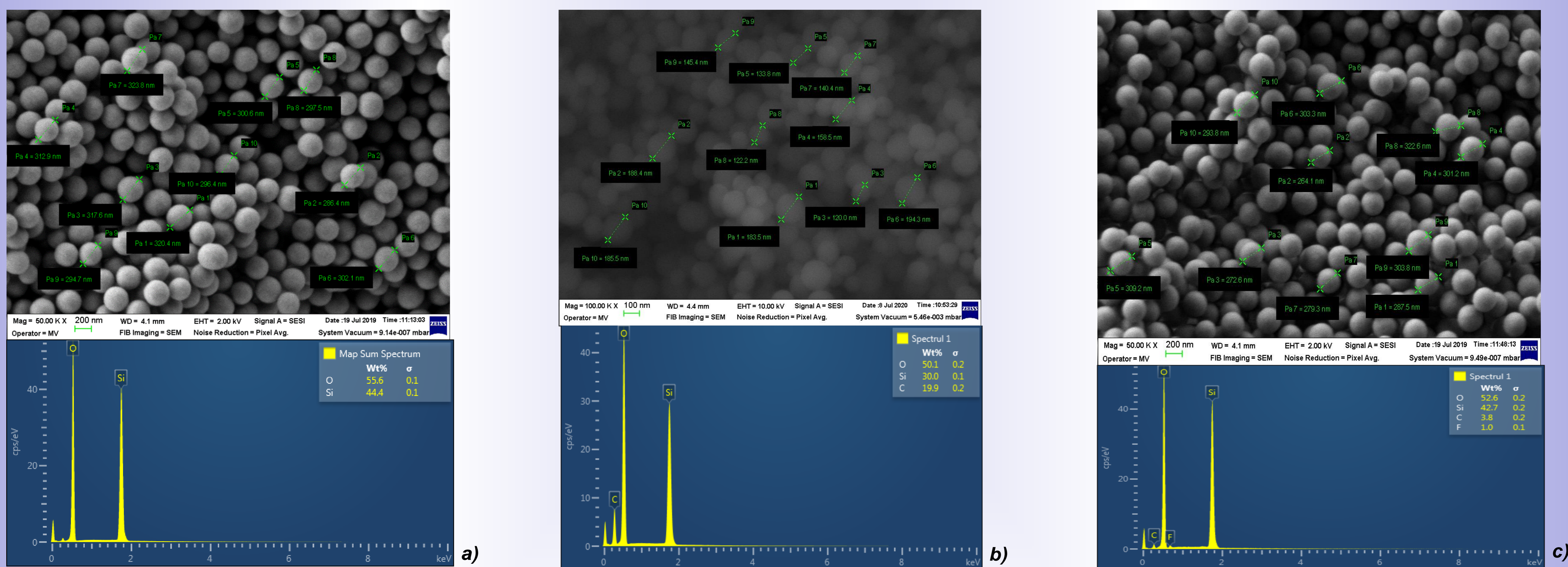


FIG. 1. SEM images and EDS of: a) SiO<sub>2</sub>; b) SiO<sub>2</sub> functionalized with HMDS; c) SiO<sub>2</sub> functionalized with PFOTS

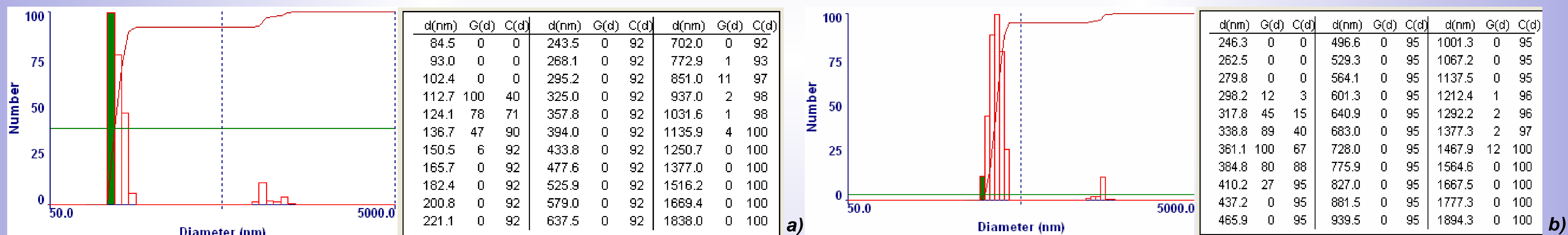


FIG. 2. Average hydrodynamic diameter and the size distribution of the nanoparticles obtained by DLS for: a) SiO<sub>2</sub> functionalized with HMDS; b) SiO<sub>2</sub> functionalized with PFOTS

## CONCLUSIONS

- SiO<sub>2</sub> and SiO<sub>2</sub> functionalized with HMDS and PFOTS nanoparticles were obtained by chemical synthesis (Stöber) and functionalization methods.
- All the obtained nanoparticles have well-defined spherical shape and clearly separated from each other, with uniform dimensions.
- EDS analysis confirmed the obtaining of silica and functionalized silica.
- The average diameter of the SiO<sub>2</sub> spheres increases after functionalization.
- The contact angle average value was ~145° for SiO<sub>2</sub> functionalized with HMDS and ~150° for SiO<sub>2</sub> functionalized with PFOTS, showing the change in the surface character of silica from hydrophilic to hydrophobic / superhydrophobic.

## ACKNOWLEDGEMENT

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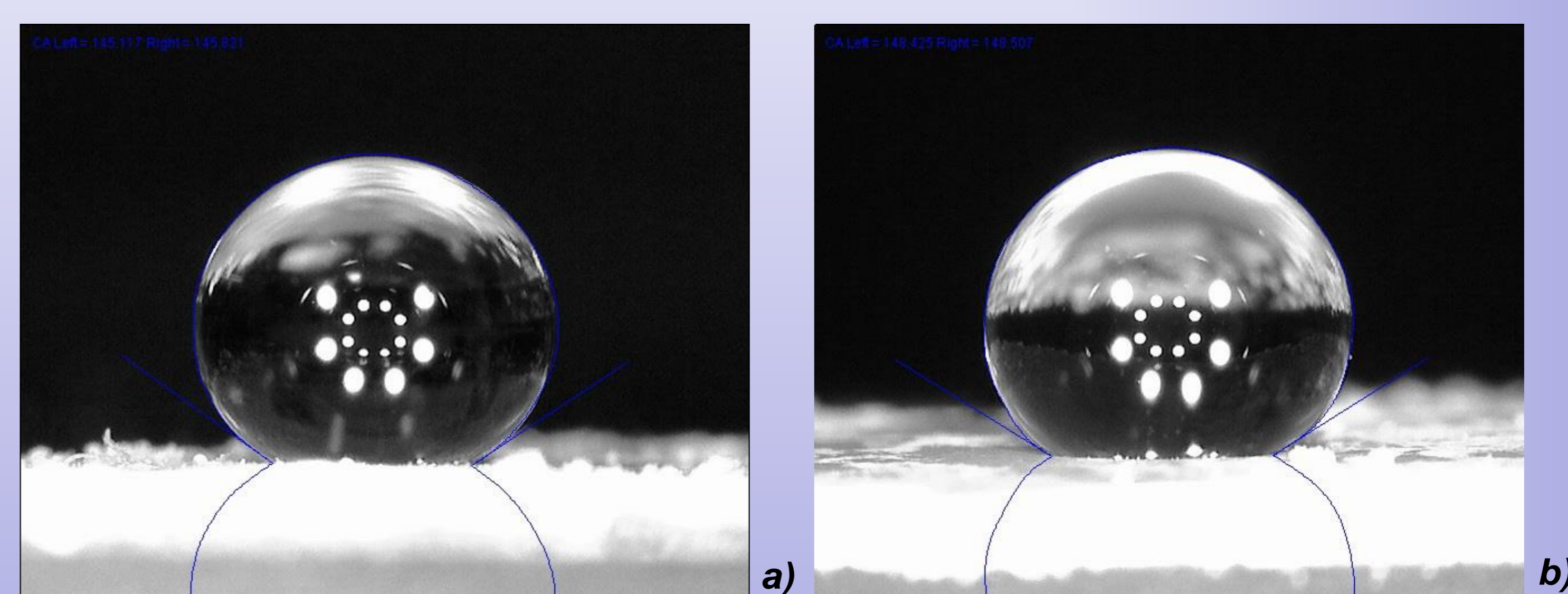


FIG. 3. Images of the water contact angle with: a) SiO<sub>2</sub> functionalized with HMDS; b) SiO<sub>2</sub> functionalized with PFOTS