Developing a superhydrophobic asphaltic material for road pavements

School of Engineering

Territory, Environment and Construction Centre

P. Machado [a], E. Freitas [a*], J. H. O. Nascimento [a*], P. Pereira [a]

[a] **Civil Engineering Department,** Territory and Environment Group
niversity of Minho, Azurém Campus, 4800-058, Guimarães, PT
***Email:** jose.heriberto@det.uminho.pt, efreitas@civil.uminho.pt

INTRODUCTION: *A superhydrophobic and icephobic surfaces, initially observed from natural materials such as lotus leafs and water striders' legs, have attracted scientific interest. It has been understood that a combination of surface roughness at both the micro and nanoscale combined with a low surface energy of the material is the key to superhydrophobicity and ice repellent. In recent years, research efforts have been made towards the development of super repellents surfaces and materials targeting a wide range of applications, from water-proof, anti ice and antifouling coatings, self-cleaning utensils, to functional microfluidic devices. Currently, there is much interest in the use of polymer as nanoscale modifiers of the surface properties of traditional asphaltic materials. A recent study showed that the combination of polymers and asphaltic materials can endow the polymer composites with both enhanced physical properties and reduced wettability.*

OBJECTIVES: *In the study, the functionalization of asphaltic materials with non polar polymers nanoparticulated and their application for super water and ice repellent properties was reported. The asphaltic material surface was coated with the polymer using a simple wet chemical process.*

EXPERIMENTAL DATA

Materials and methods

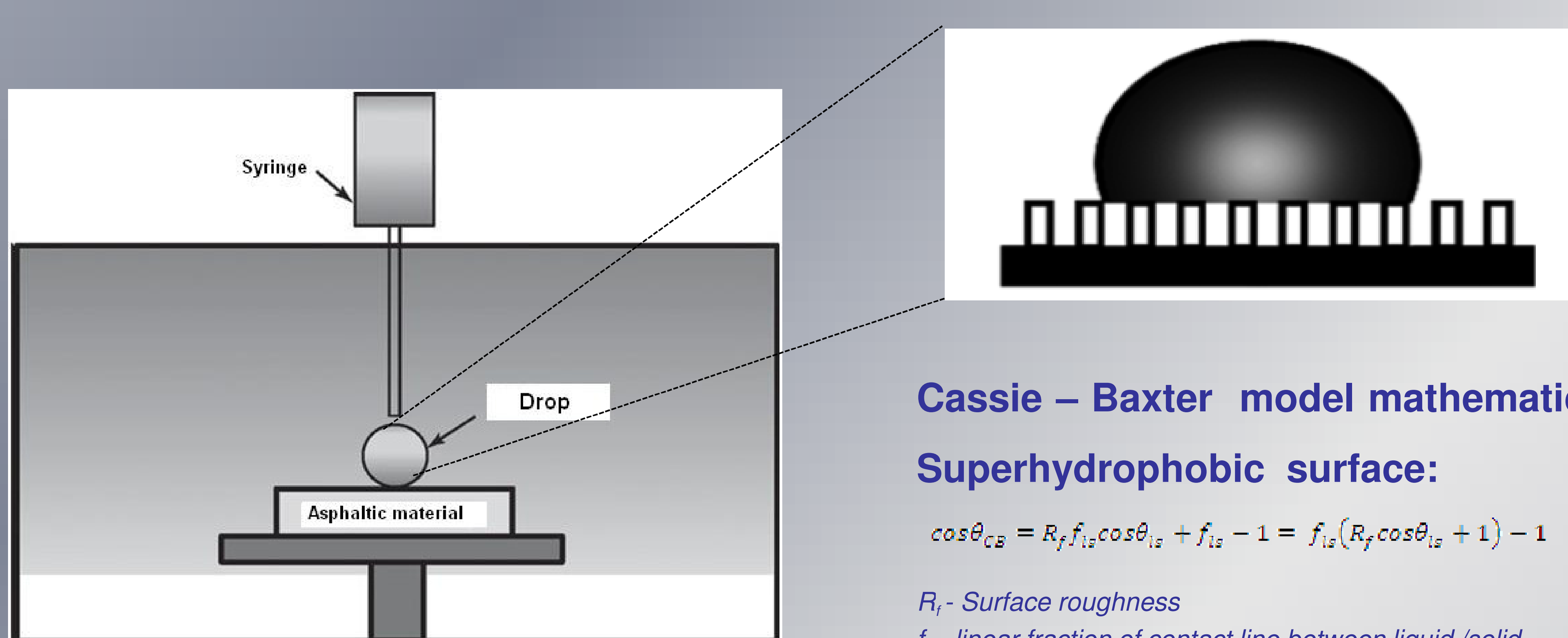
- Asphaltic Material modified as support;
- Fluoropolymer NP´s previously modified with nanoCaO in aqueous dispersion;
- Optimal concentration: 5 mg/L; pH: 5-6;
- Cure temperature: 80ºC; Time: 20 min;
- Application by wet chemical spray coating process.

Characterization

- Contact angle measurement using an apparatus OCA Plus 15: drop size de 5 µl and rate of the 5 µl / s;
- Morphological and Chemical properties by SEM and STEM using a *NanoSEM - FEI Nova 200 (FEG/SEM); EDAX - Pegasus X4M (EDS/EBSD);*
- Dynamic light scattering (DLS) measurements of the size and size distribution of nanoparticles colloidal dispersion were performed using a Malvern Instruments particle sizer (Zetasizer Nano ZS, Malvern Instruments, UK).

RESULTS

Superhydrophobic surface

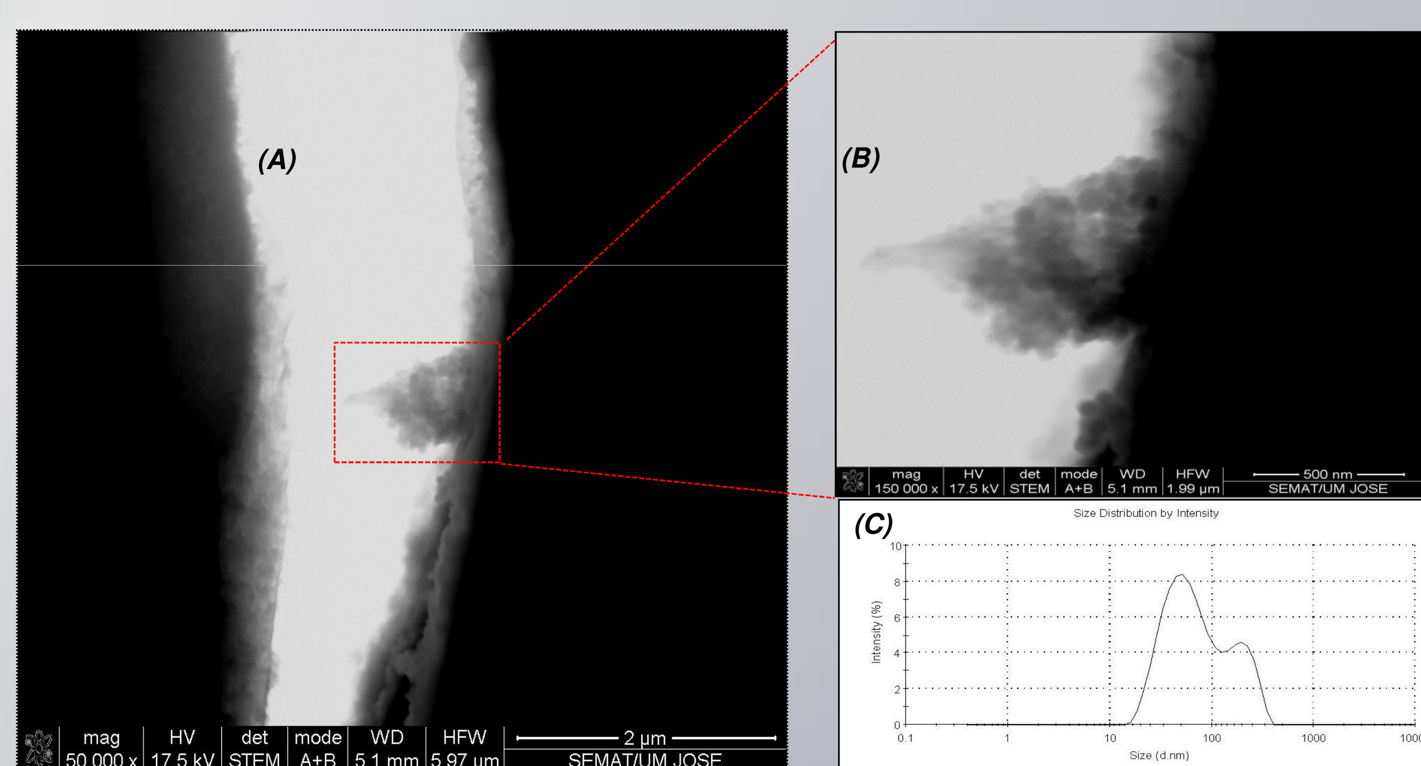


Cassie – Baxter model mathematic to Superhydrophobic surface:

$$\cos\theta_{CB} = R_f f_{ls}\cos\theta_{ls} + f_{ls} - 1 = f_{ls}(R_f\cos\theta_{ls} + 1) - 1$$

R_f - Surface roughness
f_{ls} - linear fraction of contact line between liquid /solid
θ_{cb} = contact angle between liquid and air (typically assumed to be 180°).

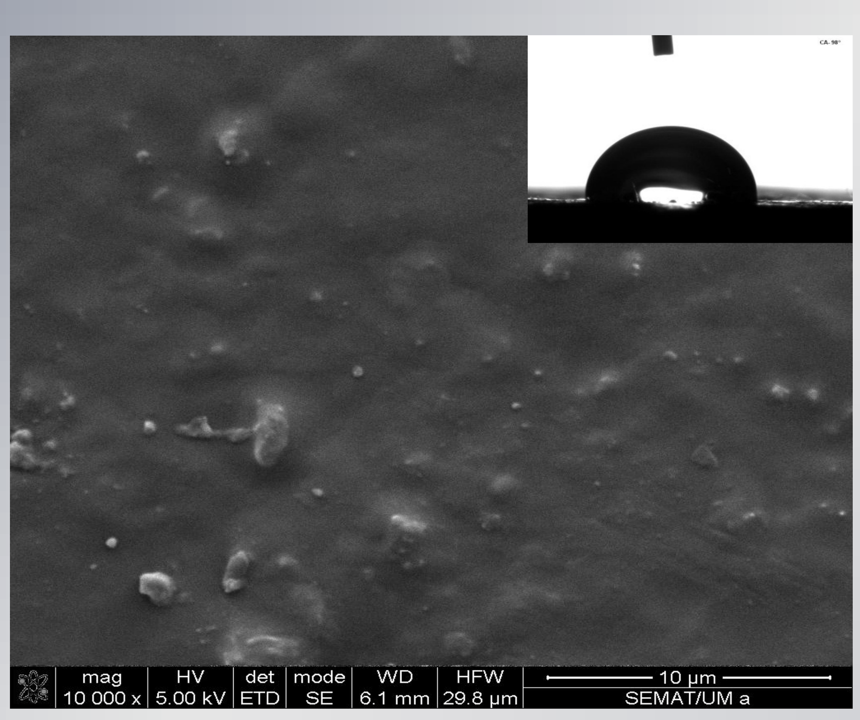
STEM images and DLS nanoparticles sizes



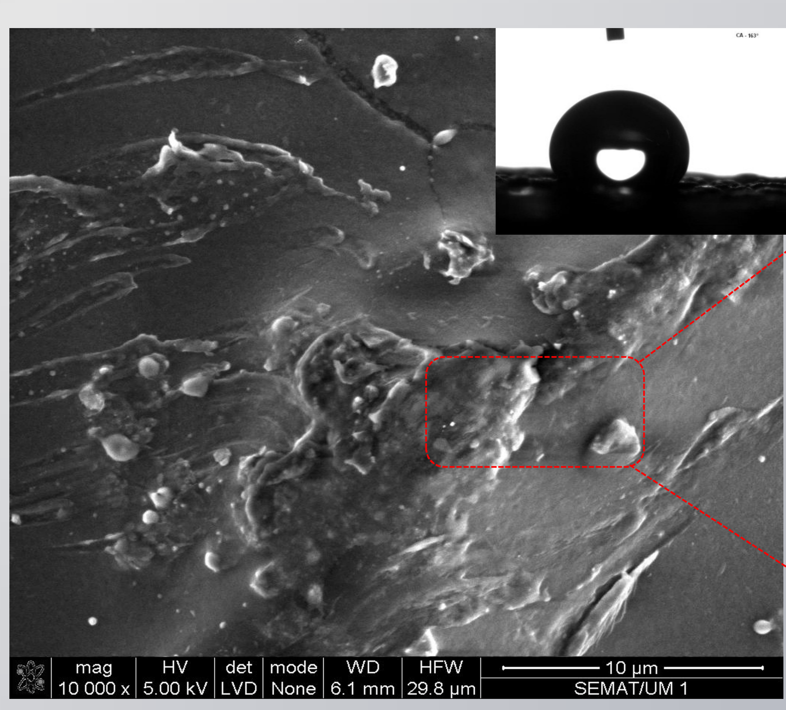
STEM image and dynamic light scattering showed the fluoropolymer and CaO nanoparticles in the same dispersion with sizes ranging between 10 and 500 nanometers (by diagram C).

This is due to the formation of agglomerates in the dispersion as shown by STEM images (A) and (B).

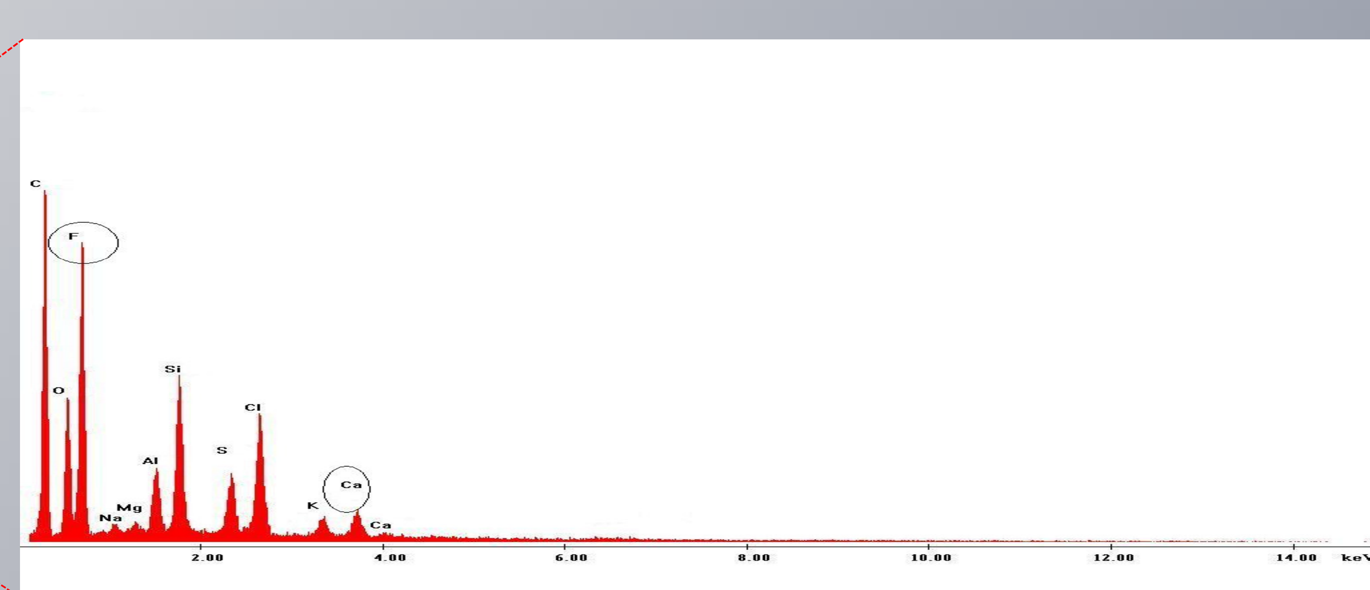
SEM and Contact Angle



SEM image without nanoparticles shows a contact angle of the 98º



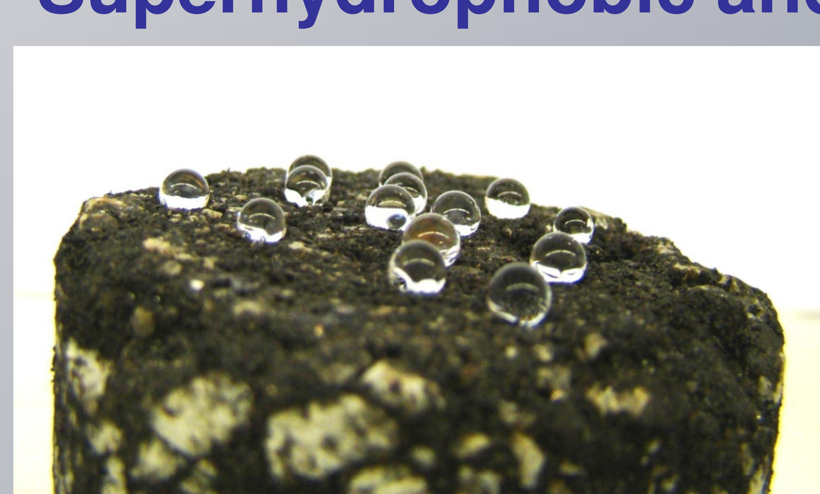
SEM image with nanoparticles shows a superhydrophobyc behavior with contact angle of the 163º



Energy dispersive X-ray analysis shows the presence of fluor and calcium, both is atomic components of the nanocoating on asphalt material with superhydrophobic properties.

Superhydrophobic and Anti ice asphaltic materials

Asphaltic material without treatment



Asphaltic material with treatment Superhydrophobic

Asphaltic material without treatment

Asphaltic material with treatment anti ice

CONCLUSION

The innovative and easy method of treatment using nanostructured materials on the asphalt material has shown excellent anti ice and super hydrophobic.

Acknowledgements: • PTDC/TRA/72998 research project - "SAFESPEED - speed management strategies: an instrument for the implementation of solutions for safe and efficient road management.“