GOLD-COATED BLACK SILICON: AN EFFICIENT SUBSTRATE FOR LASER DESORPTION IONIZATION MASS SPECTROMETRY APPLICATIONS

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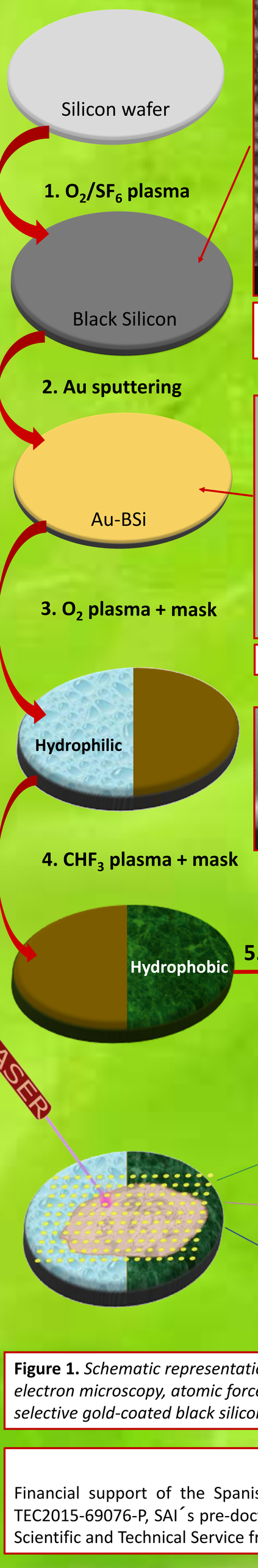
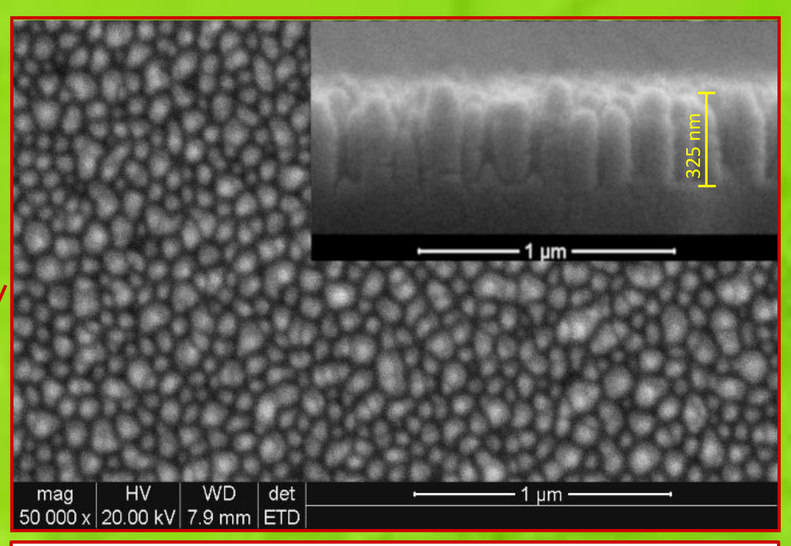
BACKGROUND

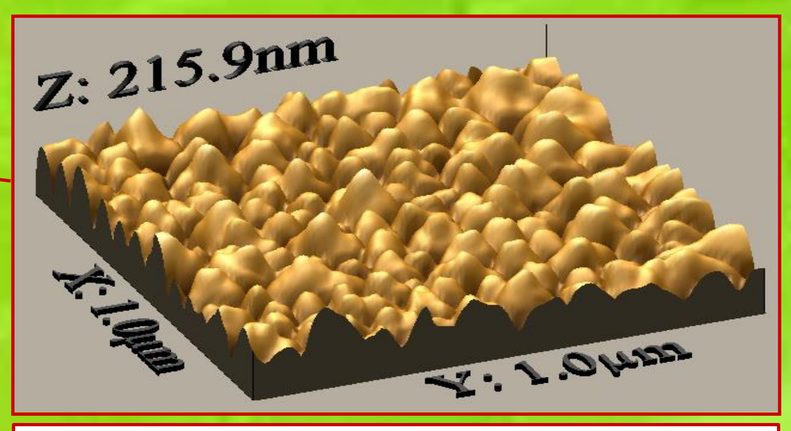
Mass spectrometry imaging (MSI) is a label-free analytical technique capable of molecularly characterizing biological samples, including tissues and cell lines. The organic matrices used in matrix-assisted laser desorption/ionization mass spectrometry experiments hamper the analysis of low molecular weight compounds (i.e. metabolites) due to the high interfering signals generated by the organic matrix itself [1]. The use of solid-state substrates instead of organic matrices is a novel and appropriate strategy to overcome this problem [2-3]. In this study we focus on developing a novel nanostructured substrate based on black silicon fabricated by reactive ion etching [4] and coated with sputtered gold. The hydrophobic/hydrophilic properties of this surface have been tailored in order to detect both polar and nonpolar compounds. This surface successfully improved the analysis of imprinted mouse brain tissues and fingerprints.

FABRICATION STEPS AND CHARACTERIZATION





Nanocolumns with ~325 nm height and average diameter of 50 nm that absorb 95% of visible light



Surface mean roughness ~ 150 nm

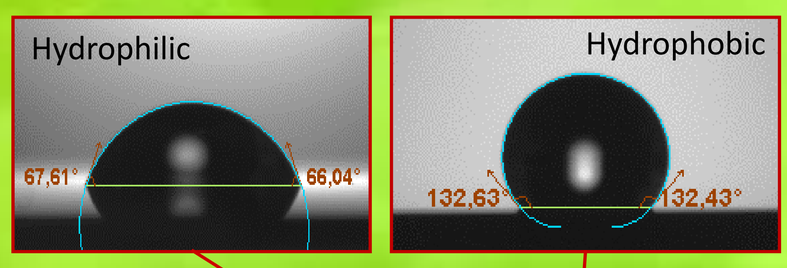


Figure 1. *Schematic representation of the fabrication steps (1-5 left) followed by scanning electron microscopy, atomic force microscopy and contact angle characterization (right) of selective gold-coated black silicon (Au-BSi) substrates for MSI applications (6)*

RESULTS

MS Images of Specific Molecules

Molecular imaging of latent fingerprint and mouse brain tissue based on specific adsorption to the Au-BSi surface was achieved. The specific physicochemical properties of the Au-BSi surface enhanced the desorption/ionization processes especially in the low mass range (<500 *m/z*) were little to no background signal was observed. Polar compounds represented by *m/z* 103.96 (Fig.2) and *m/z* 291.05 (Fig.3) have mostly adhered to the hydrophilic areas while nonpolar compounds such as *m/z* 336.89 (Fig.2) and *m/z* 178.13 (Fig.3) have adhered to the hydrophobic area for both fingerprint and brain samples.

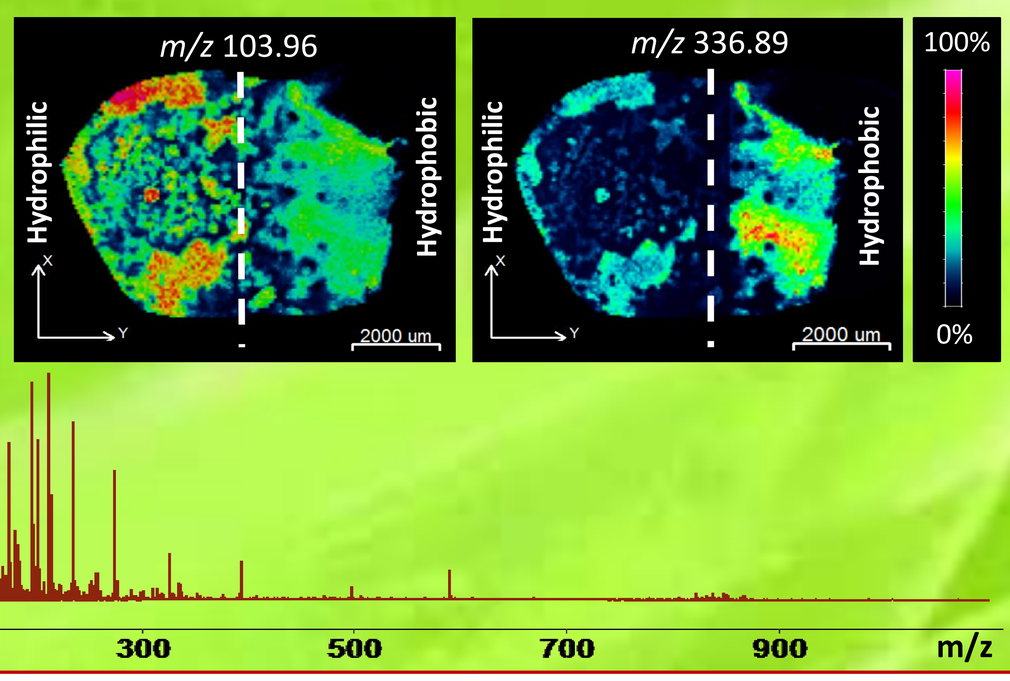


Figure 2. *Average spectra and MSI of specific ions of an imprinted mouse brain on Au-BSi*

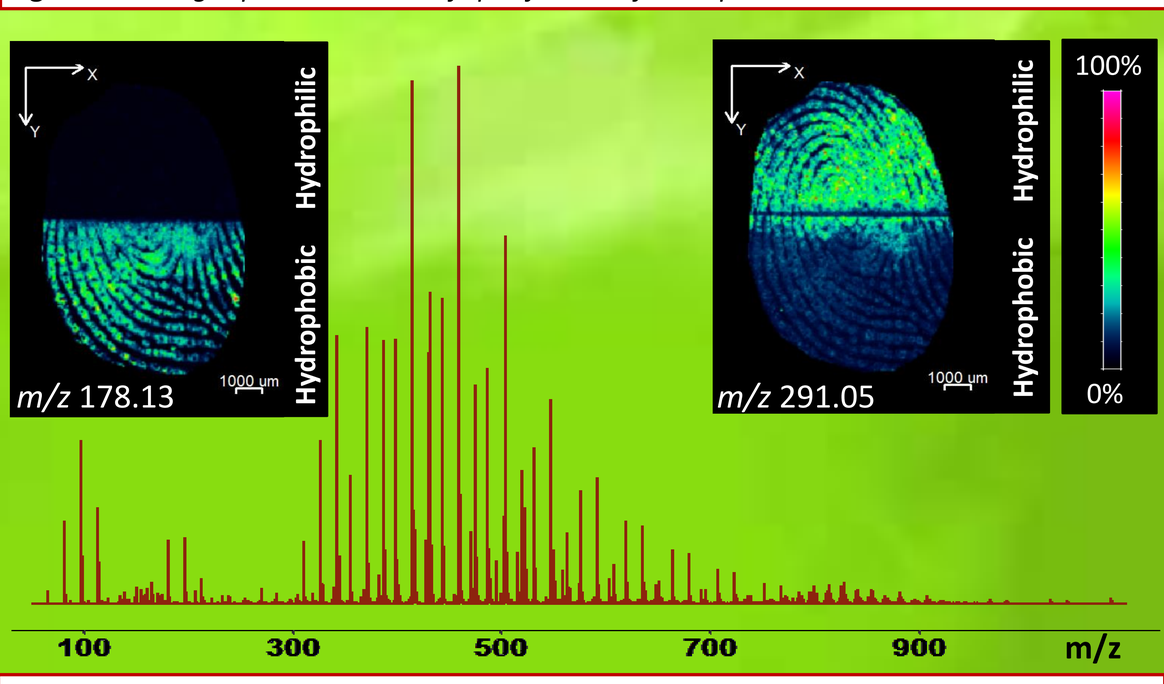


Figure 3. *Average spectra and MSI of specific ions of an imprinted fingerprint on Au-BSi*

Conclusions

Our nanostructured gold-coated black silicon surfaces enable the selective detection of hydrophobic or hydrophilic metabolites. Low background noise and high signal intensities are achieved due to the specific properties of the Au-BSi substrates. The gold nanolayer assists with the desorption/ionization processes and also provides enough mass references for an accurate mass calibration.

Acknowledgments

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References

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