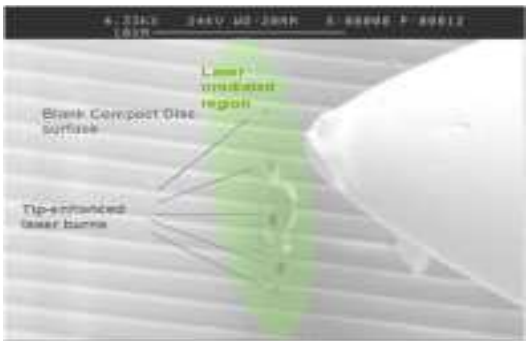
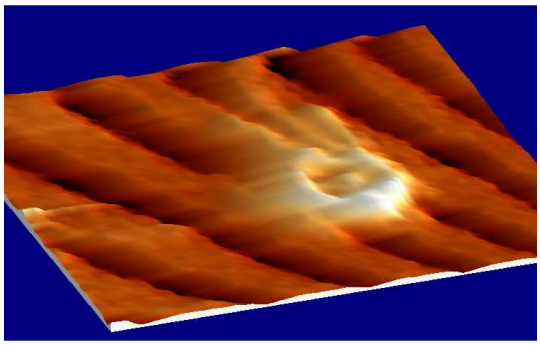
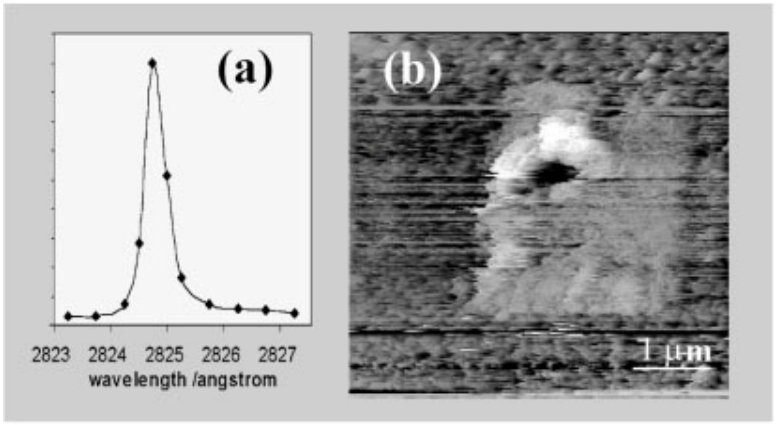
Nanofabrication technologies

Nanofabrication technology development at the ENEA UTTMAT-SUP laboratories follows two main streamlines: the development of reliable “tip enhancement” optical methods [1] based on laser radiation scattering from suitably engineered nanoantennas, and selfassemblage of biological and bio-inorganic hybrid micro and nanostructures [2].

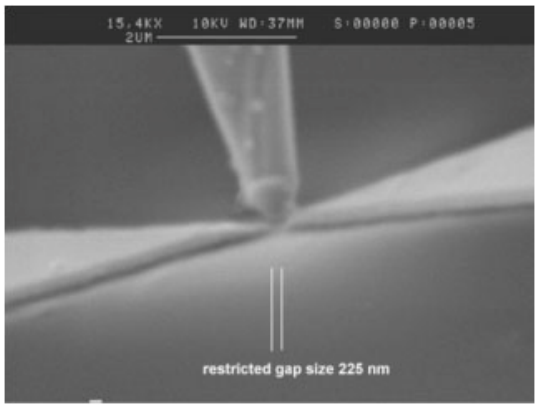




Bits can be encoded into an optical compact disc without focussing optics: the SPM tip collective electronic excitation emits electromagnetic radiation that in the near field is limited to the tip size. SEM and STM images.

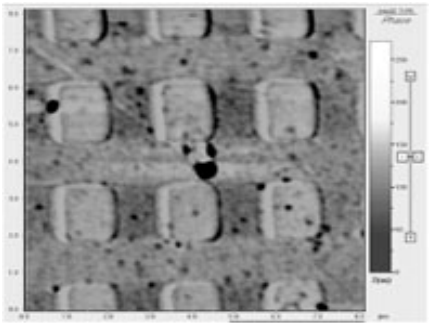


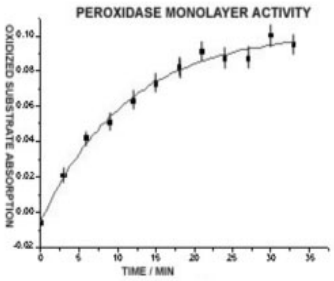
Deposition of lead atoms from a laser produced vapour pulse is effected by two-photons ionization of the vapour effected by radiation tip-enhancement while the STM is scanning. The spectrum of the photoionizatioon signal (a), ensuring that we deposit the required metal, and the subsequent STM imaging (b)



The STM probe operates under SEM observation to restrict the gap between gold nanoelectrode by tip enhancement methods

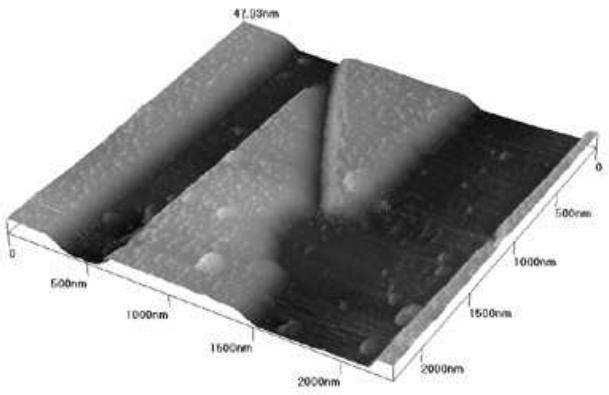
Biosensor fabrication technology exploiting high resolution lithography coupled to Pulsed Laser Deposition from frozen solutions of proteins has produced ordered arrays of biologically active 1 micron side spots of the enzyme peroxidase and of immunoglobulines.

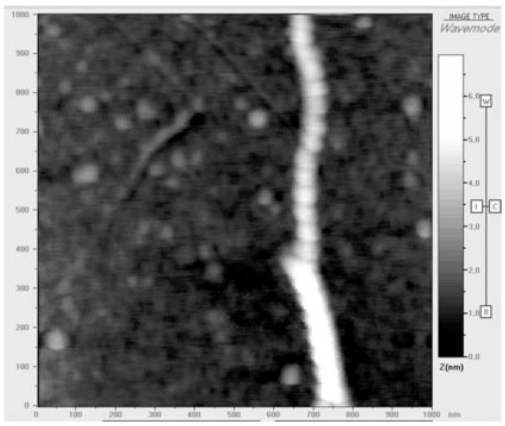




Substrate oxidation kinetiks (right) catalyzed by nanometrically patterned peroxidase layers (left) show that immobilized enzymes retain their biological activity

Truly nanometric biological structures like selfassembled DNA architectures or viral particles are being investigated as templates, moulds or stencils, together with larger complex proteic structures like spider fibers. For example, use of nanometric spider fibrils as lithographic stencils is shown to produce nanometric gaps in metal layers. 200, 500 and 15 nm channels in the 22 nm thick gold layer are fabricated (AFM image). By the same use of other biological nanostructures, like the 48 nm repeat motif displayed by the filamentous Potato Virus X, further nanometric device oriented structures can be obtained





References

[1] P. Morales, "Laser Assisted SPM Nanofabrication", in *ENCYCLOPAEDIA OF NANOSCIENCE AND NANOTECHNOLOGY NANOTECHNOLOGY* American Scientific Publishers, 2004

[2] S. Gagliardi, B. Rapone, L.Mosiello, D.Luciani, A. Gerardino, and P. Morales ; "Laser-assisted Fabrication of Biomolecular Sensing Microarrays" ***IEEE Transactions on Nanobioscience***, VOL. **6**, (2007)

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