Characterization of subwavelength spatial correlations in near-field speckle patterns

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The characterization of statistical properties of speckle patterns outside a disordered sample can provide useful information either on the microscopic structure of the medium [1,2] either on the distance between point sources embedded in the medium [3].
The non-universality character of speckles spatial correlations in the near-field (i.e. at distances < λ from the sample surface) has recently studied in experimental [5] and in theoretical works [1,4] where it has been shown that the ultimate spatial extension of the field correlation function could depend on the disordered structure of the medium. Moreover the reduced size of speckle spatial correlations in the near field represents an important potential for techniques of imaging, focusing and wavefront control in disordered media [6], since their spatial resolution is influenced by the speckle spot size.
We will show experimental results on spatial characterization of visible speckle patterns obtained by scanning near field optical microscopy (SNOM) on different volume-disordered dielectric samples. We recorded the spatial intensity distribution of the speckle patterns with subwavelength resolution at variable distances z from the surface of the medium, in a range which spans continuously from z<λ to z>λ. We have then been able to measure the speckles size in the different regimes and in particular we have been able to show the transition between the non-universal near-field character to the universal far-field behavior.

References

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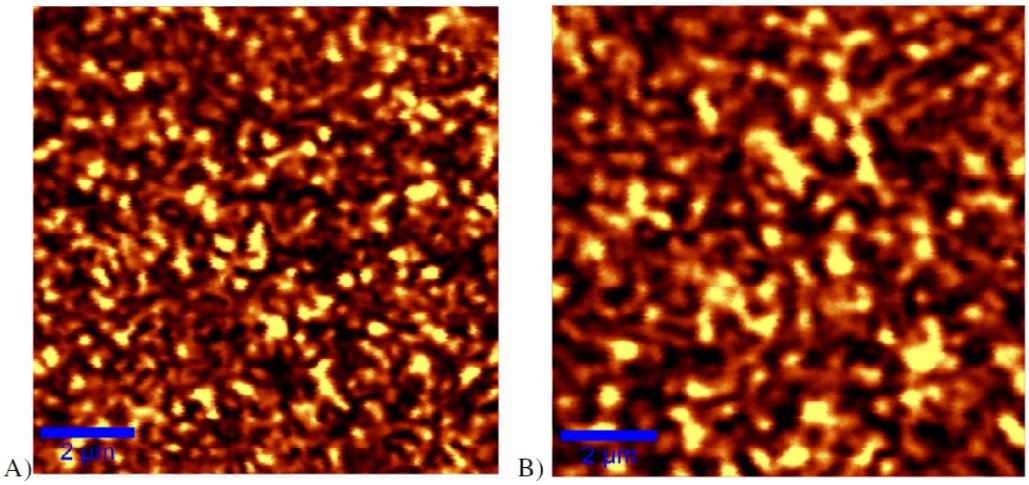
Figures



Intensity pattern recorded by SNOM (150 nm aperture) at A) 100 nm and B) 6 µm from the surface of a disordered sample made of silica spheres with average diameter of ~ 400 nm. Illuminating laser at λ=633 nm.