

Barbara Fazio

LabSENS Beyond Nano (DSFTM – CNR), Viale F. S. d'Alcontres, 31, I-98166, Messina, Italy

barbara.fazio@cnr.it

Directional beaming and localization effects in Raman light generated in random array of silicon nanowires

Disordered photonics is a new research field that is attracting a large interest worldwide for its direct implications in concrete applications such as, diagnostics [1], photovoltaics [2] and new light sources [3]. This is because the very multiple scattering nature and the light transport properties of random media allow optical performances often superior to those offered by ordered photonic structures [4]. On the other hand, the diffusive propagation of light through disordered materials gives rise to fascinating and sometimes unexpected interference phenomena surviving also in the inelastic scattering regime [5]. Here we will present recent experimental results where disordered arrays of silicon nanowires are used to generate and beam directional coherent Raman light [6]. We show the direct visualization of the weakly localized Raman radiation by both real- and momentum-space microscopy, that permitted us to gain insight on the mechanisms ruling the light transport through the random media. These results pave the way for the development of next generation of new light sources based on both the coherent control of directional beaming and the fine frequency tuning.

References

- [1] J. Bertolotti, E.G. van Putten, C. Blum, A. Lagendijk, W.L. Vos, and A.P. Mosk. *Non-invasive imaging through opaque scattering layers*. Nature 491: 232-234, 2012.
- [2] O. L. Muskens, J. G. Rivas, R. E. Algra, E. P. A. M. Bakkers, and A. Lagendijk, *Design of Light Scattering in Nanowire Materials for Photovoltaic Applications*, Nano Lett. 8: 2638–2642, 2008.
- [3] D. S. Wiersma. *The physics and applications of random lasers*, Nat. Phys. 4: 359–367, 2008.
- [4] B. Fazio, P. Artoni, M.A. Iati, C. D'Andrea, M.J. Lo Faro, S. Del Sorbo, S. Pirotta, P.G. Gucciardi, P. Musumeci, C.S. Vasi, R. Saija, M. Galli, F. Priolo, and A. Irrera. *Strongly Enhanced Light Trapping in a Two-dimensional Silicon Nanowire Random Fractal Array*. Light: Science & Applications, 5: e16062, 2016.
- [5] B. Fazio, A. Irrera, S. Pirotta, C. D'Andrea, S. Del Sorbo, M.J. Lo Faro, P.G. Gucciardi, M.A. Iati, R. Saija, M. Patrini, P. Musumeci, C.S. Vasi, D.S. Wiersma, M. Galli, and F. Priolo. *Coherent Backscattering of Raman Light*. Nature Photonics 11: 170-176, 2017.
- [6] M.J. Lo Faro, G. Ruello, A.A. Leonardi, D. Morganti, A. Irrera, F. Priolo, S. Gigan, G. Volpe, and B. Fazio. *Visualization of directional beaming of weakly localized Raman from a random network of silicon nanowires*. Advanced Science, 2100139, 1-11, 2021. DOI 10.1002/adv.202100139.

Figures

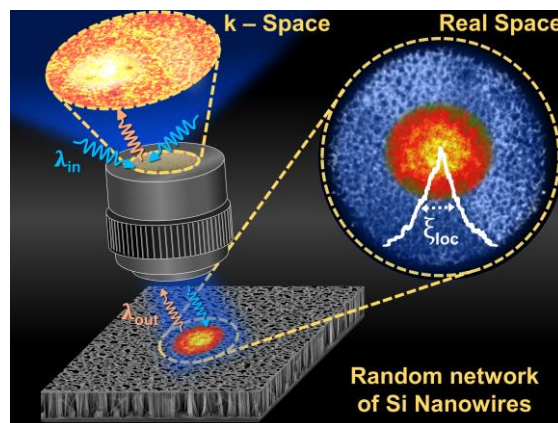


Figure 1: Visualization of coherent Raman light arising from a Si NWs random network: localized light paths in the real space and directional beaming in the momentum space.