# Self-assembled self-tuned random lasers

**R. Sapienza[1], P. D. García[1], J. Bertolotti[2], S. Gottardo[2], M.D. Martín[3], A. Blanco[1], L. Viña[3], D.S. Wiersma[2], C. López [1]**

[1] *Instituto de Ciencia de Materiales de Madrid* and *Unidad Asociada CSIC_U Vigo*
*Calle Sor Juana Inés de la Cruz 3, 28049 Madrid España*
[2]*European Laboratory for Nonlinear Spectroscopy & INFM-BEC, 50019 Sesto Fiorentino (Florence), Italy*
[3]*Departamento de Fisica de Materiales, Universidad Autonoma de Madrid, Cantoblanco 28049 Madrid España*
*sapienza@icmm.csic.es*

The special care needed to produce high quality photonic crystals is, surprisingly, also needed to produce photonic glasses[1], random and solid arrangement of dielectric spheres, because, upon sedimentation, certain colloidal particles show a strong tendency to order which has to be broken. Only conscientious attempts to fully remove order lead to structures fully devoid of any remnants of order as evidenced by optical properties or microscopy.

Light transport in photonic glasses becomes resonant, the diffusion constant and the transport mean free path show minima and maxima when the Mie modes of the spheres are excited. Also the energy velocity in such media shows a resonant behaviour[2]. With this material it is possible to create random lasers in which the lasing wavelength can be decoupled from gain profile and selected at will.

A random laser is a system formed by a random assembly of elastic scatters dispersed into an optical gain medium. Multiple light scattering replaces standard optical cavity of traditional lasers and the interplay between gain and scattering determines its unique properties. Random lasers studied to date, consisted of irregularly shaped or polydisperse scatters, with some average scattering strength that is constant over the frequency window of the laser. We consider the case where the scattering is resonant. Photonic glasses can sustain scattering resonances over the gain frequency window, since it is formed by monodisperse spheres of relatively high refractive index contrast that are randomly assembled. The unique resonant scattering of this material allows controlling the laser emission via the diameter of the particles and their refractive index. Our system is therefore a random laser with a-priori designed lasing peak within the gain curve [3].

**References**

[1] P. D. García, R. Sapienza, Á. Blanco and C. López, "Photonic glass: a novel random material for light" Adv. Mater. 19,2597-2602 (2007)

[2] R. Sapienza, P.D. García, J. Bertolotti, M.D. Martín, A. Blanco, L. Viña, C. López, D.S. Wiersma, "Observation of Resonant Behavior in the Energy Velocity of Diffused Light" Phys. Rev. Lett. 99, 233902 (2007)

[3] S. Gottardo, R. Sapienza, P.D. García, A. Blanco, D. S. Wiersma, and C. López, "Resonance-driven random lasing" *Nature Photonics* **2** (7), 429-432 (2008)