A possible cause of this might be different qualities of powder compression and nanoparticle packing.

The observation of lifetimes longer than in air indicates the reduction of LDOS in the scattering medium. We believe this conclusion is robust against systematic effects. First, opening of non-radiative decay channels, e.g. as a result of contact with the medium, cannot be responsible for this effect since it could only increase the total decay rate $\gamma = \gamma_{\mathrm{r}} + \gamma_{\mathrm{nr}}$ and therefore lower the lifetime. Second, lengthening of the fluorescence lifetime cannot be explained in the context of a homogeneous medium with an effective index of refraction because addition of high-index TiO_2 particles could only increase such an effective refractive index with respect to that of the air-glass interface, and thus, reduce the lifetime. Finally, we verified that the longer fluorescence decay was not the result of photon trapping in the scattering medium. To do this, we focused 10 ps pulses of laser light onto the interface between the cover glass and the scattering medium to mimic the spatial mode of the DNC emission. We then interrogated the temporal profile of the reflected light in a confocal detection arrangement with and without the scattering medium. This allowed us to rule out any pulse lengthening within the time resolution of 0.4 ns.

Our measurements provide the first report of the fluctuations of the spontaneous emission rate in a disordered scattering medium. Our experimental approach sets the ground for studying strong localization of light by monitoring and mapping the variations of the local density of states directly in the coordinate space. Such studies promise to connect the nanoscopic behavior of light scattering with conventional macroscopic ensemble measurements. An important advantage of this approach is that observation of the inhibition of the spontaneous emission rules out systematic effects of absorption since those would always lead to a reduction of the fluorescence lifetime.

The experiments reported here can be improved in several ways. First, particle composition and compactification of the scattering medium can be varied and characterized [21]. Second, use of color centers with narrow emission spectrum in the near infrared [22] could simplify the analysis of the density of states in comparison to the broad emission of NV centers. Another advantage of such emitters would be the availability of very strongly scattering media based on large-bandgap semiconductors [23]. Furthermore, we plan to extend our work to the measurement of the fluorescence lifetime via a thin optical fiber that carries a single DNC attached to its end placed deep into a three-dimensional scattering medium [24].