Nonlinear optical study of lyotropic-like human Low-Density Lipoproteins in the thermal time-scale regime

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Lyotropic liquid crystals are mesophases formed by the mixture of amphiphilic molecules and a solvent, under particular conditions of temperature and relative concentrations of the constituents. The polymorphism of the structures formed in these mixtures is very rich. The amphiphilic molecules aggregate forming micelles, bicontinuous or even large anisotropic closed structures. Nonlinear optical properties of lyotropic mesophases, in particular the nonlinear index of refraction, were investigated, by using the Z-Scan (ZS) experimental technique [1]. It was observed that changes in the micellar arrangement modify some nonlinear optical responses of the medium. Lyotropic liquid crystals have an interface with biology, which opened a new manner to investigate some aspects of living system. This task may be achieved facing problems existing in the physical-chemistry of lyotropics. The cellular membrane present similarities with the amphiphilic bilayers of lyotropic structures. The structure of the human lipoproteins is also similar to that of the lyotropic micelles: phospholipids form a shell around a lipid core. The typical diameter of the Low-Density Lipoprotein (LDL) is of the order of 20 nm, comparable to some micellar dimensions in lyotropics. We show that the nonlinear optical response of native LDL is very different from that of modified (mainly oxidized) LDL [2]. Modified LDL were associated to the development of different pathologies, in particular, atherosclerosis. In this communication we will discuss the nonlinear optical response of aqueous solutions of LDL obtained from patients with diabetes and periodontitis (before and after the dental treatment). We investigate the optical and structural characteristics of LDL particles modified by glycation compared to modified-control and native LDL. The experimental methods were the ZS, dynamic light scattering and small-angle X-ray scattering. The ZS experiments indicate that glycated LDL drastically modifies the nonlinear optical properties of the LDL, decreasing the amplitude of the typical peak-to-valley response curve. On the other hand, control LDL still keeps some of the optical properties of the native LDL. These results indicate the possible application of a nonlinear optical technique as a tool to investigate the structure of LDL and improvement in the predictive power of cardiovascular events in relation to the lipid and glycemic profile present in diabetes. Despite the fact that *in vitro* procedures do not reproduce exactly the physiological conditions, the results obtained from this type of approach may shed some light on the understanding of the complex living system.

[1] Alves, S., Cuppo, F.L.S. and Neto, A.M.F, Determination of the nonlinear refractive index of lyotropic mixtures with and without ferrofluid doping: a time-resolved Z-scan experiment in millisecond time scales, J. Opt. Soc. Am. B, Vol. 23, No. 1, 67, 2006.

[2] Alves, S. and Neto, A.M.F, Advances in the non-linear optical investigation of lyotropic-like low-density human lipoproteins in the native and oxidised states, Liquid Crystals, Vol. 41, No. 3, 465, 2014.