Pressure effects on the protein dynamical transition

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Keywords: Neutron scattering, dynamical transition, high pressure

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The Protein Dynamical Transition (PDT) consists in a steep increase in the temperature dependence of the flexibility of proteins occurring at about 200K. One of the most powerful techniques for its investigation is incoherent neutron scattering, which can give a measure of the Mean Square Displacements (MSD) of the non-exchangeable protein hydrogen atoms, as firstly shown by Doster and co-workers in 1989 [1]. The biological relevance of PDT has been pointed out and its physical origin has raised debates in the literature, still being an open question today [2-6]. Studies of protein structural dynamics in general, and of the PDT in particular, as a function of pressure would be highly desirable both to help clarifying its physical origin and from a more biological point of view, since many biological systems live at high hydrostatic pressure.

Very few studies have addressed the problem of the pressure dependence of protein dynamics as studied with neutron scattering, and most of them have been concerned with samples in solution investigated near room temperature [7,8]. Studies on the pressure dependence of the PDT on protein systems are lacking, probably because of the relevant experimental challenges.

We report here on the temperature dependence of the MSD of Myoglobin (Mb) in an ultraviscous mixture of protein/D8-Glycerol/D_2O [9], in the temperature range 20-300K, and at different pressure values, from ambient pressure to 5 kbar. Data have been analysed within a double well potential model and show a significant reduction of protein dynamics with increasing pressure up to 2 kbar; a sudden MSD increase is observed between 2 and 3 kbar, likely related to protein pressure induced denaturation. However, the pressure effect decreases the MSD amplitude without altering the PDT onset temperature (see figure 1). Implications of these findings to the Mb energy landscape will be discussed.

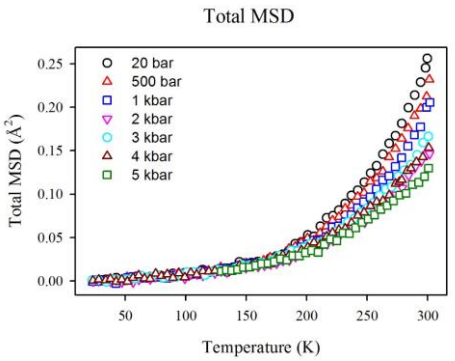

Figure 1. MSD of Myoglobin as function of temperature at different pressure conditions.

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