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NMR relaxation in partially saturated pores: applications to porous glasses and cement paste

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Nuclear magnetic resonance (NMR) relaxometry techniques are widely used for the characterization of porous materials. They exploit the proportionality between the relaxation rate and the surface to volume ratio of the investigated pores. The proportionality constant, also called relaxivity, is determined by the adsorption properties of molecules on the pore surface [1], the magnetic impurity content of the solid matrix [2,3] and the magnitude of the external magnetic field [1-3]. Consequently, the relaxation experiments provide us access to the pore size distribution and the wettability of the confined fluids. Most NMR relaxation studies of molecules confined inside porous media refer to saturated conditions. In fact, saturated conditions are a priori assumed in many applications, even if in reality we have to deal with partially saturated pores. That is why, in the present study the relaxation of water and cyclohexane molecules partially saturating a porous glass (VitraPor#5; pore size: 1 μm) and a white cement paste (nanometer and micrometer sized pores) was considered as a function of the filling degree [4, 5]. The two porous materials were selected due to the presence of OH groups on their surfaces. The two filling liquids were selected as representatives of polar (water) and nonpolar (cyclohexane) molecules which should experience different interactions with a surface containing OH groups [1, 2]. Stronger interaction was observed in the case of water filled porous samples as compared with the cyclohexane filled ones. This property was exploited to clearly identify the different categories of pores in cement paste with pore sizes ranging from nanometers to micrometers. It was also observed a different drying process of the three types of pores and a different molecular distribution inside these pores. Information about liquid distribution under partially saturated conditions could be also extracted.

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