The Measurement of Residual Dipolar Couplings in Most NMR Solvents Using Gel-Induced Alignment

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Residual dipolar couplings (RDCs) contain valuable information for defining and verifying the conformation and configuration of compounds and are of high interest for biomolecular as well as small molecule applications. For their measurement, solute molecules of interest must be partially aligned inside an anisotropic matrix. One possible matrix with high flexibility are stretched gels, which we will focus on here.

A number of gel-based alignment media for practically all NMR solvents will be presented (see also already published work [1-6]). The latest generation of alignment media involves deuteration of the polymer so that NMR signals originating from the alignment medium are minimized and the acquisition of homonuclear ^{1}H-^{1}H-correlation experiments inside the polymer gels is possible with high spectral quality.

Gel-based alignment can also be applied in combination with a mechanical stretching device which allows rapid and arbitrary adjustment of alignment strength. The device was originally designed for molecules dissolved in gelatin gels as the corresponding alignment medium [7,8] and was used recently in our laboratory for measuring RDCs with very high precision [9]. Here, a redesigned and optimized gel stretching apparatus is introduced for the measurement of RDCs on small as well as larger compounds in basically any kind of NMR solvent. The core of the apparatus consists of a specifically designed tube made out of highly stretchable Kalrez®Perfluoroelastomers with excellent resistance to practically all chemicals. Since the polymer tube is perfluorinated, it does not contribute in any way to the proton NMR spectrum. First examples of RDC-measurements with the novel apparatus will be shown.

Having stretched polymer gels as alignment media in hand, the measurement of corresponding RDCs usually involves standard NMR-techniques. However, the wide distribution of dipolar couplings and the special needs of small molecules at natural abundance with the presence of CH, CH_2, and CH_3 groups led to the development of a number of pulse sequences in our laboratory. Some of them will be described (see e.g. [10-12]).

[1] Luy, B., Kobzar, K., Kessler, H., *Angew. Chem. Int. Ed.* **2004**, *43*, 1092-1094.
[2] Luy, B., Kobzar, K., Knör, S., Furrer, J., Heckmann, D., Kessler, H., *J. Am. Chem. Soc.* **2005**, *127*, 6459-6465.
[3] Freudenberger, J. C., Spiteller, P., Bauer, R., Kessler, H., Luy, B., *J. Am. Chem. Soc.* **2004**, *126*, 14690-14691.
[4] Freudenberger, J. C., Knör, S., Kobzar, K., Heckmann, D., Paululat, T., Kessler, H., Luy, B., *Angew. Chem. Int. Ed.* **2005**, *44*, 423-426.
[5] Kobzar, K., Kessler, H., Luy, B., *Angew. Chem. Int. Ed.* **2005**, *44*, 3145-3147.
[6] Kummerlöwe, G., Luy, B., *J. Am. Chem. Soc.* **2007**, *129*, 6080-6081.
[7] Kuchel, P.W., Chapman, B.E., Müller, N., Bubb, W.A., Philp, D.J., Torres, A.M., *J. Magn. Reson.* **2006**, *180*, 256-265.
[8] Naumann, C., Bubb, W.A., Chapman, B.E., Kuchel, P.W., *J. Am. Chem. Soc.* **2007**, *129*, 5340-5341.
[9] Kummerlöwe, G., Halbach, F., Laufer, B., Luy, B., *The Open Spectroscopy Journal* **2008**, *2*, 29-33.
[10] Tzvetkova, P., Simova, S., Luy, B., *J. Magn. Reson.* **2007**, *186*, 193-200.
[11] Klages, J., Kessler, H., Glaser, S.J., Luy, B., *J. Magn. Reson*. **2007**, *189*, 217-227.
[12] Enthart, A., Freudenberger, J.C., Furrer, J., Kessler, H., Luy, B., *J. Magn. Reson*. **2008**, *192*, 314-322.