Probing Hydrogen Bonding by Solid-State NMR

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Solid-state MAS NMR experiments utilising recently developed methodology such as homonuclear 1H decoupling and through-bond J correlation are yielding new insight into hydrogen bonding interactions that control the packing of organic molecules into three-dimensional structures.

Specifically, the 1H chemical shift is a sensitive indicator of hydrogen-bonding strength and aromatic pi-pi interactions, with high-resolution 1H double-quantum (DQ) experiments enabling the identification of proton-proton proximities [1]. Using the enhanced resolution obtained in a 1H DQ CRAMPS experiment [2], the ability to detect a specific pseudo polymorphism of an active pharmaceutical ingredient in a tablet formulation has been demonstrated [3]. The effect of intermolecular weak (CH…O) hydrogen bonding on chemical shifts has been quantified by CASTEP calculations for periodic solids [4].

Complementary information is yielded from N-H…N hydrogen-bond mediated $^{2h}J_{NN}$ couplings: hydrogen-bonding partners can be unambiguously identified in refocused INADEQUATE spectra [5], while hydrogen-bonding strength can be quantified by the measurement of the J couplings in spin-echo experiments [6]. Specifically, different intermolecular hydrogen-bonding arrangements as well as their strength have been determined in synthetically modified guanosines, so as to identify different modes of self-assembly, namely quartet or ribbon formation [7,8].

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