NMR Applications for Polymer Characterisation

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The Principles of NMR in Polymer Characterisation

- **NMR C**hemival **S**hift instead of **R**etention **T**ime
- Target molecule must be soluble in deuterated solvent
- Qualitative **and** quantitative analysis is possible.
- NMR signals show molar response.
- One characteristic signal without interference is needed
- Temperature dependent analysis (RT up to 80°C).
- Drugs and/or formulations can be analysed in complex matrices.

Common chromatographical methods often fail in polymer analytics. Therefore multi-nuclear NMR spectroscopy should be established in phar-macopoeia as an alternative for qualitative and quantitative methods.

Polymers are widely spread in drug design. Exemplary six different target compound groups are presented.

- Silicone (Polydimethylsiloxane)
- Polysaccharides (Drugs and Galenics)
- Polyether (Galenics)
- Polyester (Galenics)
- Poly- and Oligopeptides (Drugs)
- Polyvinyl Compounds (Galenics)

Fig. 1

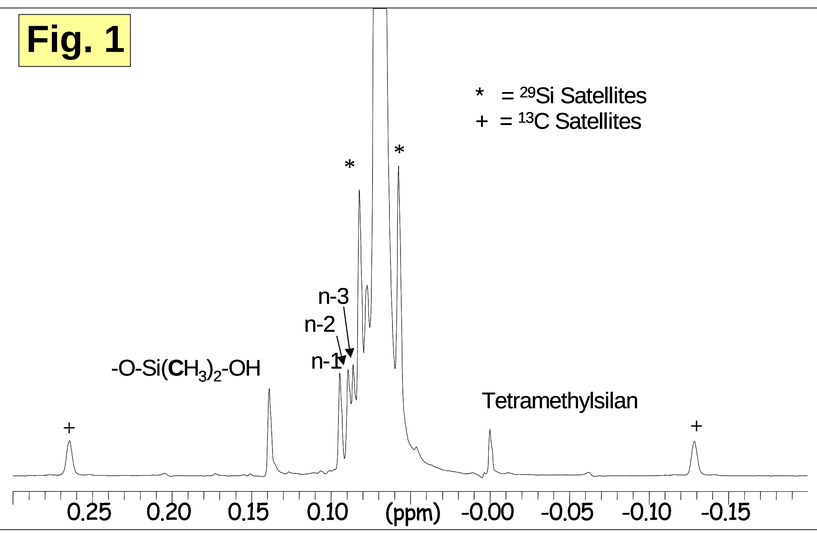


Fig. 1 shows the ^{1}H NMR spectrum of an OH terminated **Polydimethylsiloxane (PDMS**). These polymer family can be quantified in drugs using the intensive singlet of the $Si(CH_3)_2$ groups and an internal standard. The method correlates with FT/IR but has a much lower detection limit (aprox. 1ppm). The high spectral dispersion allows the analysis of cyclic types (**Fig. 2**), end-groups (OH, TMS or other modified) and the mean chain length. ^{29}Si and ^{13}C satellites are useful calibration signals

Fig. 2

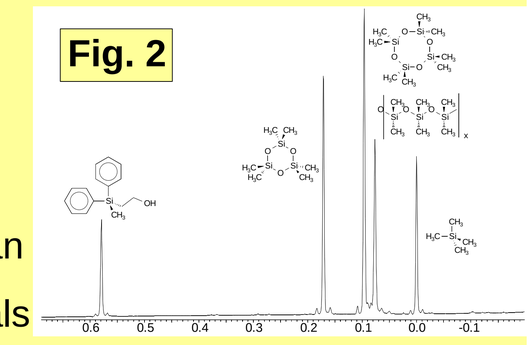
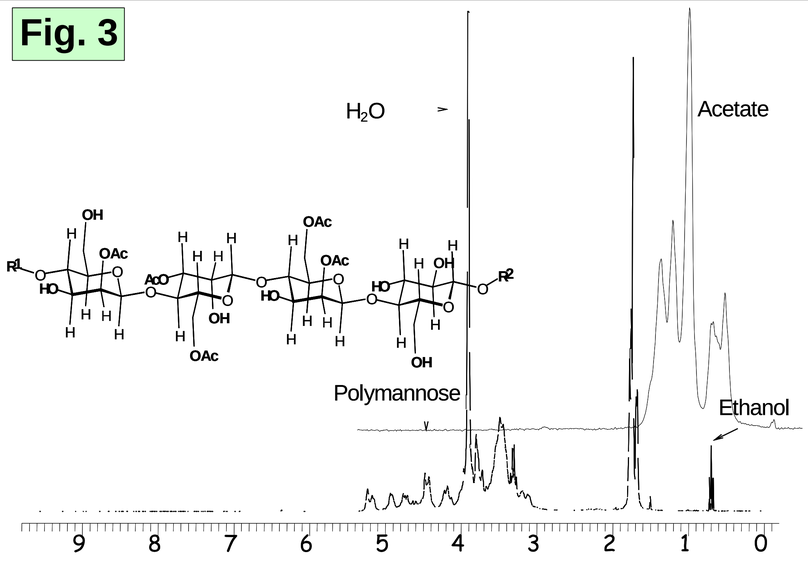
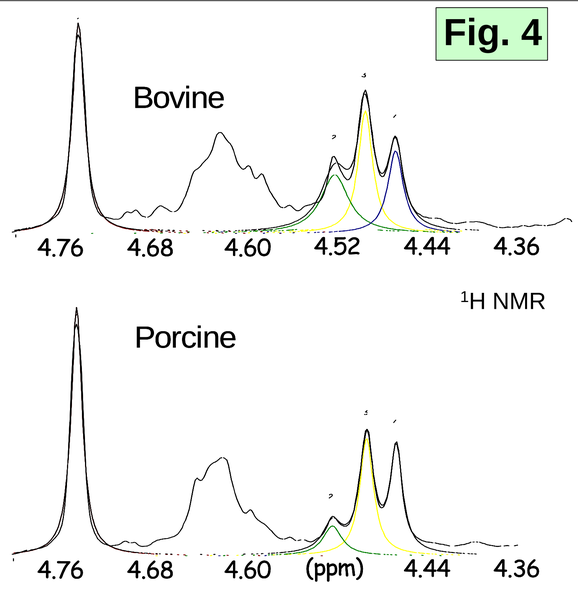


Fig. 3



Polysaccharides represent the biggest group of polymers used in drugs. **Fig. 2** shows the 1H NMR spectrum of Aloverose, an acetylated polymannose from Aloe Vera. The fingerprint signal of the the acetate enables an origin test and a quantification. **Fig. 3** shows the comparison of chondroitin sulfates.. These high temperature analysis allows to distinguish between different animal origin (e.g. bovine, porcine, sharc, chicken). The method is useful for other muco-polysacharides like heparines, too.

Fig. 4



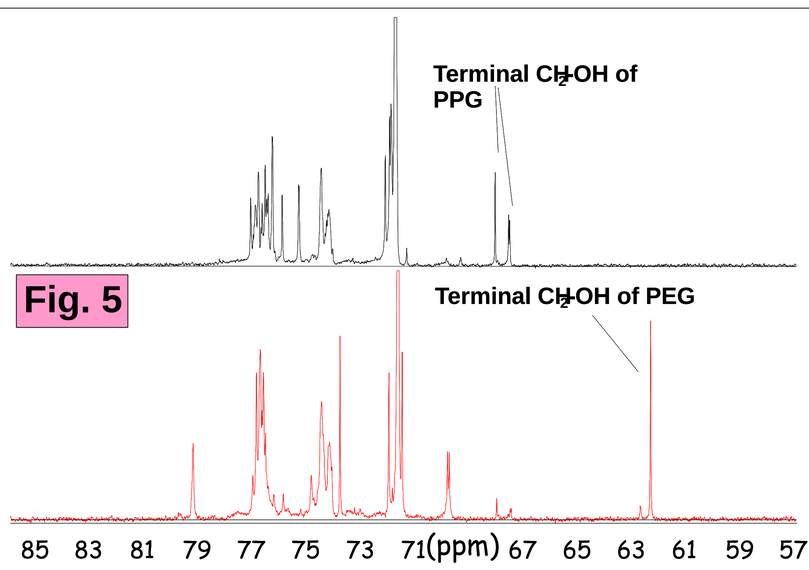


Fig. 5

Polyether, **Polyester** and **Polyvinyl** compounds mostly are used as formulation aids. **Fig. 4** shows a comparison of ^{13}C NMR spectra of PEG/PPG copolymers with different sequence of the polymer blocks. **Fig. 5** shows the ^{1}H NMR of a drug formulation (top) and for comparison the reference of the corresponding Polymer CoPo Luviscol K 120 (bottom).

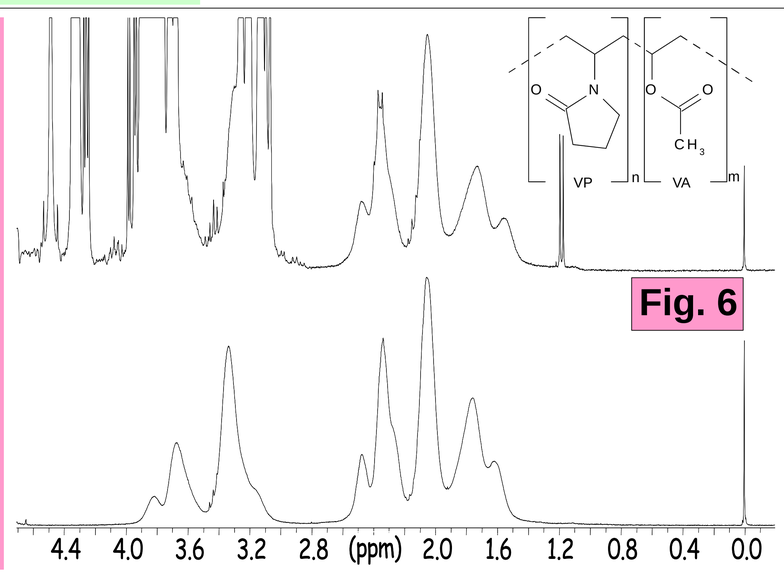
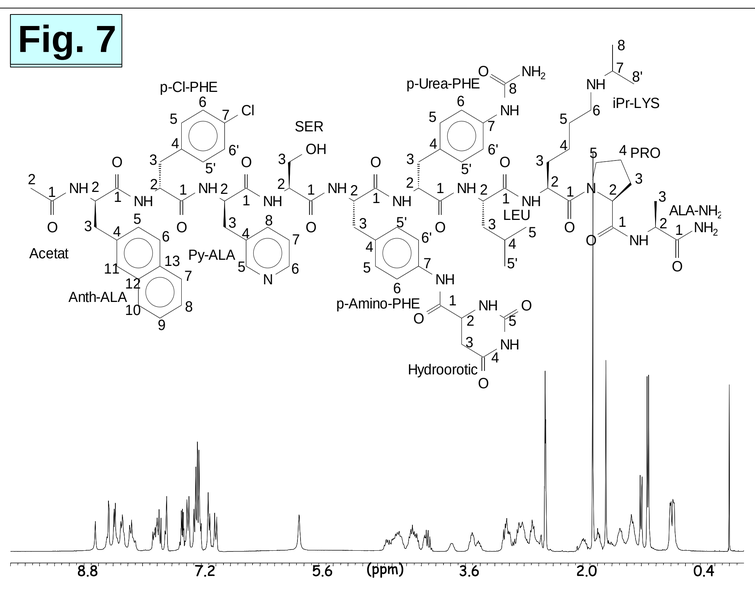


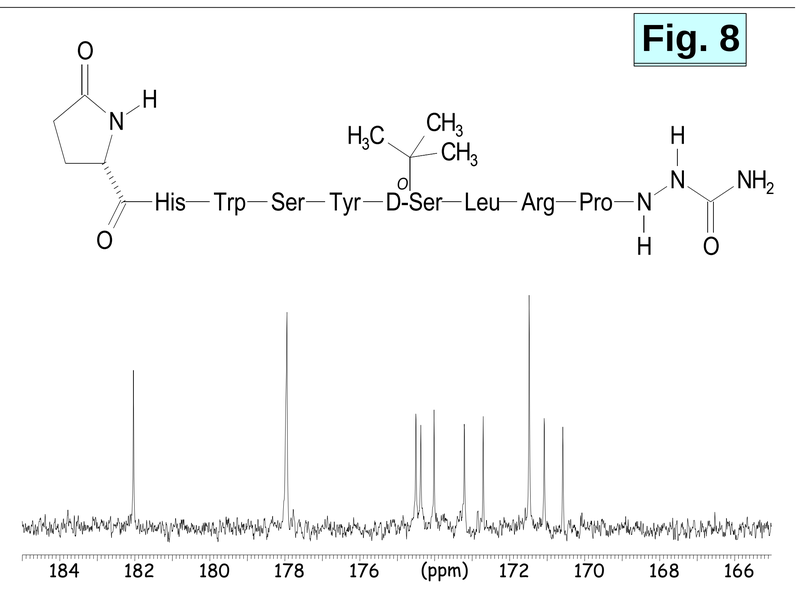
Fig. 6

Fig. 7



Poly- and **oligopeptides** are the most interesting polymers in drugs. Several types already are characterised in some pharma-copoeia. **Fig. 6** shows the 1H NMR spectrum of an oligopeptid. The carbonyl region of goserelin is a characteristic part of the ^{13}C NMR spectrum (see **Fig 7)**.

Fig. 8



NMR spectrometer Avance 300 (BRUKER, Karlsruhe, D), magnetic flux density 7,05 Tesla PA BBI probe head