DNP-NMR Spectrometers and Microwave Source

Dynamic Nuclear Polarization (DNP) experiments transfer polarization from electron spins to nuclear spins for large gains in sensitivity and a dramatic reduction in signal averaging time. Bruker DNP-NMR spectrometers are designed specifically for extended solid-state NMR experiments, delivering unsurpassed sensitivity for exciting new applications in biological solids, material science and pharmaceuticals.

DNP samples are prepared by adding a polarizing agent to a shared solvent or exploiting a native radical in the sample of interest. Experiments are performed under MAS conditions at low temperature, 100-180 K and with continuous microwave irradiation. The custom-designed gyrotron microwave source operates at 263, 395 or 527 GHz for DNP-enhanced NMR experiments at 400, 600 or 800 MHz. Bruker DNP spectrometers have a proven record of performance, with 25 systems installed to date.

Materials Science Applications

Studies of small-core CdSe quantum dot (QD) materials:
- QDs exhibit desirable electronic and optical properties that are size-tunable.
- DNP provides enhancements ~80-fold ($^{113}$Cd) with straightforward sample preparations.
- Core, surface and ligand sites can be readily identified and probed; unlike in larger QDs, core signals show large enhancements, enabling further study of their properties.

Low Temperature MAS DNP Probes

DNP probes are available in the following configurations to cover a range of applications at 400, 600 and 800 MHz:
- 3.2 HCN, HX or HXY with variety of X/Y combinations (15 kHz MAS at 100 K)
- 3.2 mm low-gamma probe (15 kHz MAS at 100 K)
- 1.9 mm HCN at 600 and 800 MHz (25 kHz MAS at 100 K)
- 1.3 mm HCN at 600 and 800 MHz (40 kHz MAS at 100 K)

Biological Solids Applications

DNP enables rapid characterization of large biological assemblies, such as intact Pf1 virus.
- MAS at 25 kHz (in 1.9 mm rotors) can improve enhancement and resolution for difficult biological samples.
- DNP signal enhancements and non-uniform sampling (NUS) enable rapid acquisition of multidimensional experiments.
- Assignments are simplified by use of long-range transfer sequences (e.g. sequential sidechain correlation, CANCOCOA).
- Resolution of uniformly $^{13}$C, $^{15}$N-labeled protein samples is sufficient to permit assignments and distance measurements.

Summary

- Turn-key solution for DNP-enhanced solids NMR experiments at high field.
- Unique high power CW gyrotron microwave sources and waveguide.
- Low-temperature (100 K) MAS probe technology with built-in waveguide and cold spinning gas supply.
- Sweep coils on DNP NMR magnets.