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Inelastic neutron scattering in pursuit of interesting neutron-moderating materials

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The way to identify and characterize potentially interesting neutron-moderating materials is to measure their neutronic properties: vibrational density of states (VDoS) and total cross-section. The idea behind the VDoS measurements is to look for low energy vibrational modes that can enable efficient moderation of neutrons in the so-called cold energy region.

TOSCA instrument [1] at the ISIS is an indirect-geometry inelastic neutron spectrometer optimized for high resolution vibrational spectroscopy in the energy transfer region between -24 and 4000 cm-1 which makes it a perfect tool for the determination of VDoS of moderator material candidates in the cold region such as Triphenylmethane [2] or solid methane[3].

In this work, the measurements of VDoS of a number of hydrocarbons, which can be of interest for neutron moderation, will be described. The candidate materials have been chosen if they satisfy the following conditions: they have relatively high proton density (one of the main requirements for a good moderator); they have benzene ring(s) - this could imply that they are less prone to radiation damage; they are liquid at room temperature and solid at the cryogenic temperatures (so relatively easy for operation). Using these criteria the following materials have been chosen: para-cymene (C10H14), thymol (C10H14O), mesitylene (C9H12) and toluene (C7H8). Mesitylene and toluene have been extensively studied in the moderator development work at JINR Dubna [4] but the idea here was to compare a mixture of mesitylene and para-cymene with a mixture of mesitylene and toluene under different cooling and annealing conditions for different fractions of the mixture constituents.

[1] R. Pinna et al., Nuclear Inst. and Methods in Physics Research, A 896 (2018) 68–74.
[2] G. Škoro et al., EPJ Web of Conferences 239, 17008 (2020).
[3] R. Granada, Talk at the Workshop on Very Cold and Ultra Cold Neutron Sources at the ESS, Feb 2022.
[4] I. Natkaniec et al., Physica B 350 (2004) e651–e653.

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