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To all members of the
Faculty of Physics

Vienna, 21 January 2025

Invitation to the public defense of the doctoral thesis

"Polymer based photonic materials for cold neutron optics"

by

Elhoucine Hadden

Tuesday, 28 January 2025, 13:00 p.m.
Digital
Zoom Link:
https://univienna.zoom.us/j/66385959800?pwd=JnMpvovlUpgdimaDBXQayEpXNkoxzt.1

This research advances the study of light and neutron diffraction in holographic gratings through model development, material optimization, and tailored experimental methodologies. The focus is on achieving high scattering length density (SLD) modulation and structural stability, and on providing the necessary tools for analyzing the intricate and variable nature of neutron diffraction data. Simplified first-order adaptations of the Rigorous Coupled-Wave Analysis (RCWA) theory were developed to enable accurate and computationally efficient analysis.

Material studies cover Bayfol® HX200 photopolymers, nanodiamond-based nanoparticle composites (NDPC), and hyperbranched polymer (HBP) dispersed nanocomposites, each evaluated for suitability in light and neutron diffraction. Commercial Bayfol foils, in particular, were optimized for neutron diffraction, with certain writing intensities and dosages enhancing their efficiency. Both light and neutron diffraction patterns aligned with the predictions of the non-local photopolymerization-driven diffusion (NPDD) model, offering insight into the underlying processes influencing optical performance.

NDPC gratings achieved record-breaking SLD modulation amplitudes with high diffraction efficiency, minimal angular and wavelength selectivity losses, and robustness that supports their application in advanced neutron optics, including a planned very cold neutron (VCN) interferometer for 2025. HBP gratings similarly exhibited high modulation amplitudes, positioning them as promising candidates. Experimental setups were refined for noise reduction, and a rigorous data reduction and background treatment protocol was developed to accurately derive diffraction efficiency across varied setups. Bayesian inference methods, including Markov Chain Monte Carlo sampling and Bayesian Model Selection, were also introduced as supplementary tools for probabilistic model validation in cases with extensive parameter ranges or nonuniformities.

Through theoretical, material, and experimental advancements, this thesis establishes a framework for future interdisciplinary research in neutron optics and holography, contributing to the ongoing development of diffraction-based applications in materials science and fundamental physics.

Defense committee:
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