Raman spectroscopy investigation of alkene-based anti-relaxation coating

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Abstract— New alkene-based anti-relaxation coating of alkali metal vapor cell demonstrated up to 10 times longer relaxation time then the same time for classical alkane-based coating. In this paper the interaction of Cs vapor with the surface of the alkene in vacuum is studied by optical Raman spectroscopy. Isomerization of alkene (double bound of C=C moving to center) was found.

Keywords— alkene Raman spectroscopy; spin relaxation; surface physics; alkali metal atoms; adsorption; optical pumping

Introduction

Anti-relaxation coatings of inner surface of alkali vapor metal cells are used in experiments of quantum optics, magnetometry and frequencies standards. They significantly increase relaxation time of ground state spin polarization due to suppression of the atoms–glass-wall collisions.

Traditionally, a material for anti-relaxation coating is mixture of alkanes (paraffines) because of its chemical inertness to alkali metal atomic vapor. But the longest relaxation time (up to 70 sec.) was demonstrated with the usage of alkene-based anti-relaxation coatings (1).

As it was demonstrated in paper (2) alkali metal atoms can interact (e.g., be absorbed) with cells walls. The absorption process is the most intensive just after the cell manufacturing.

The results of investigation of pure and alkali metal exposed coatings material by Raman spectroscopy method are presented at this paper. This method was chosen because its high sensitivity to chemical structure of material and high optical transparency of Pyrex type glass to pumping light used in Raman spectrometer.

I. EXPERIMENT DESCRIPTION AND RESULTS

Express-Raman spectrometer SENTERRA (Bruker) and its standard pumping laser 785nm (100 mW) with automatic fluorescence rejection were used. We were trying to use very similar conditions for spectra recording for all samples.

The Raman spectra of three special samples were obtained: a) coatings inside of real experimental Cs vapor cell b) pure alkene in evacuated tube, c) alkene in vacuum exposed to Cs, (Fig. 1). Two upper spectra are different from the one on the bottom (squared on Fig. 1). The samples where alkene doesn’t interact with alkali metal atoms have a strong peak at 112cm⁻¹ and 1643 cm⁻¹. In contrast, the samples where alkene has long exposure to Cs (like two upper spectra) have not peak at

112cm⁻¹ and 1643 cm⁻¹ peak moved to 1673 cm⁻¹. According to (3) these changes correspond to moving of double bounds from alpha position to center of molecule.

Fig. 1. Raman spectra from bottom to top: blue - vacuum tube with the coating material and Cesium vapor immediately after preparing, red - the same after heating at 80C during a month, purple – standard Cesium vapor cell with alkene anti-relaxation coated walls.

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REFERENCES