Light Induced Desorption of Alkali Atoms from OTS Coated Cell for the Electron Electric Dipole Moment Search

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journal or publication title	CYRIC annual report
volume	2012-2013
page range	34-36
year	2013
URL	http://hdl.handle.net/10097/59505

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The nonzero value of eEDM provides the direct signature for the violation of CP, where C and P represent charge conjugation and parity symmetry, respectively, under CPT conservation. It is an important clue for understanding the mechanism of the matter-antimatter asymmetry in the universe. As the values of eEDM predicted by several theoretical models such as supersymmetry model etc. are quite small, a lot of experimental techniques based on a laser cooling of atoms or a buffer gas cooling of molecules have been proposed and performed for the precise measurement of the signal yielded by eEDM[1)].

Francium (Fr) atom, which is the heaviest alkali atom, is one of the strong candidates for the eEDM search because the large electric filed produced by the nucleus increases the sensitivity of the measurement by a factor of about 895[2)]. The eEDM experiment using laser cooling and trapping techniques of Fr atom has a potential for improving the sensitivity of that performed by ThO[1)]. However, Fr is a radioactive atom, and the cyclotron operation is required for its production. Therefore, it is a major challenge to increase the number of Fr atoms captured by laser lights and to reduce the statistics error.

In the glass cell, most of Fr atoms are adsorbed on the surface of glass and not trapped by laser lights. Light-induced atomic desorption (LIAD) is one of the useful techniques to desorb these atoms. When atoms on the surface are irradiated by lights, these atoms are desorbed from the surface. This is capable of increasing the number of trapped atoms. Inner wall of the Pyrex glass cell is coated with octadecyltrichlorosilane (OTS) which is one of the dryfilms. OTS reduces the strength of the interaction between the alkali vapor and the Pyrex glass[3)]. Test experiment of LIAD using rubidium (Rb) from OTS coated glass has been performed at CYRIC. Rb is one of the alkali metal atoms, and its chemical property is similar to that of Fr.

The experimental apparatus is depicted in Fig. 1. The Rb dispenser is located under the neutralizer to supply Rb atoms inside the OTS coated glass cell. MOT is formed by three pairs of counterpropagating laser lights and the quadrupole magnetic field. The number of atoms trapped in MOT is detected by a CCD camera. To confirm the effect of LIAD, we use white flash light (430EX II, Canon) which is fixed above the MOT glass cell. The flash light from the device is emitted to the MOT glass cell and the desorbing effect from the OTS coated cell is observed.

The signal of LIAD is shown in Fig. 6. The vertical axis is the intensity of the trap area which is detected by the CCD camera, and the horizontal axis is time. The number of trapped atoms at t = 180 s is 103. The intensities of the steep peaks after t = 180 s gradually decreased. This indicates that the number of desorbed atoms on the surface of OTS coated glass cell reduced due to the LIAD effect.

This result is expected to be applied for increasing the number of trapped Fr atoms. We will investigate the photon energy dependence for the LIAD effects. We will confirm LIAD effect from yttrium surface which neutralizes Fr and Rb ions beam.

References

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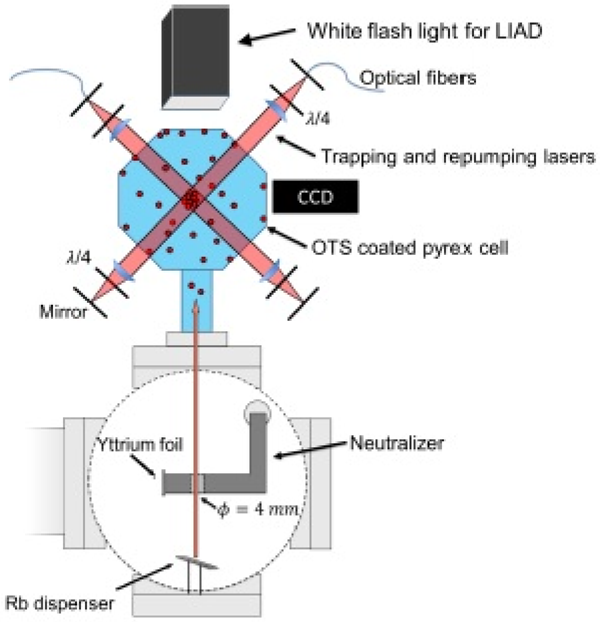

Figure 1. Setup of LIAD experiment.

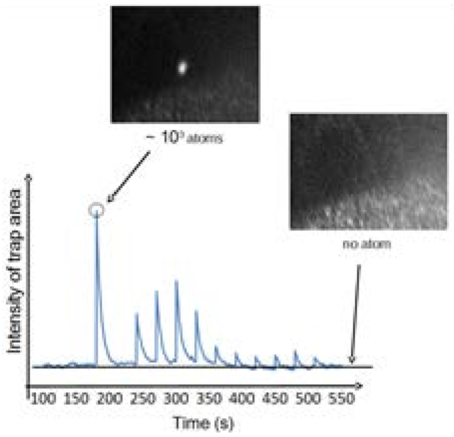

Figure 2. LIAD from OTS coated Pyrex cell.