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Study of temperature dependence of adsorption rate of OTS coatings and optimization for trapping of Fr

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Francium (Fr), the heaviest alkali element, is predicted to exhibit the largest enhancement factor of electron electric dipole moment (EDM) among alkali atoms, making it a promising candidate for probing physics beyond the standard model. To realize a high-precision EDM measurement with Fr, laser cooling and quantum control techniques are typically employed. In our experiment, we aim to trap Fr atoms in an optical lattice. A crucial requirement for this approach is the ability to confine many Fr atoms in a localized measurement region for an extended period. To increase the number of trapped atoms, we utilize a coated glass cell. The coating material used is octadecyltrichlorosilane (OTS: $C_{18}H_{37}SiCl_3$), which can be chemically applied and is known as its anti-adsorption properties for glass surface.

In this context, we consider four key factors: (1) the adsorption rate of Fr atoms on the coating surface, (2) potential contamination caused by evaporation or degradation of the coating material (particularly during a vacuum bake out), (3) the reflection behavior of Fr atoms in the absence of adsorption, and (4) scattering of external light (e.g., optical lattice beams) from the coated surface.

This study focuses particularly on the second issue, investigating the temperature dependence of adsorption rate and thermal stability of the OTS coating. Our goal is to optimize system conditions for effective trapping of Fr and thereby improve the overall performance of EDM measurements using Fr atoms.

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