Laser interaction at gas-solid interface. Linear, surface and quadratic terms in the $\vec{A} \cdot \vec{p}$ gauge

G. Raşeev [1] and **D. Bejan** [2]
Laboratoire de Photophysique Moléculaire du CNRS,
bât. 210, 91405 Orsay, France

At gas-solid interface the electron density, the dielectric function and the electric field of the photon vary sharply. Therefore, the usually assumed approximation of the spatially independent field of the photon does not hold anymore. In this contribution we obtain the sharp spatial variation of the dielectric function at the interface from the calculated electron density in a jellium model and the Fresnel relations at abrupt interface. The resulting dielectric function is then related, through the index of refraction and the wave vector, to the vector potential $\vec{A}$. The resulted vector potential $\vec{A}$ is then used in the laser-matter interaction Hamiltonian written in the Coulomb gauge and the $\vec{A} \cdot \vec{p}$ (notation **Ap**) formulation. The associated scalar potential is set to zero because the interaction between the charges of the material system is much stronger than the electromagnetic radiation of the laser. For $\mathfrak{p}$ polarization, our detailed theoretical analysis unravel four terms linear in $\vec{A}$: a term perpendicular, two terms parallel and a surface term perpendicular to the surface, all four varying at the interface. There are also two terms quadratic in $\vec{A}$: a term perpendicular and a term parallel to the surface, again all varying at the interface. Using this laser-matter interaction operator, we calculate all the laser-matter interaction terms for a (001) metallic surface lightened by a laser of 2 eV. The results for several metals, calculated with an elementary wave function product of a sum of Gaussian functions normal to the surface and plane waves perpendicular to it, show, at non-destructive fluences, a comparable relative importance for one linear term parallel to the surface and one surface term perpendicular to it but a negligible contribution of the quadratic terms. In conclusion the variation of the electron density at interface engender to new terms in the interaction between the laser and the matter and in particular a characteristic surface term that disappears for the normal incidence. The strength of this surface term can then be unravelled.

[1] Fax: +33 16915 6777; e-mail: Georges.Raseev@ppm.u-psud.fr

[2] Permanent address : Faculty of Physics, University of Bucharest, P.O. Box M.G.11, Bucharest, Magurele, Romania.