High-Order Harmonic Generation from the Cu(111) surface

To cite this article: Néstor F. Aguirre *et al* 2015 *J. Phys.: Conf. Ser.* **635** 102010

High-Order Harmonic Generation from the Cu(111) surface

Néstor F. Aguirre*[1], Sergio Díaz-Tendero*, Fernando Martín*†‡

* Departamento de Química, Módulo 13,Universidad Autónoma de Madrid, 28049, Madrid, Spain

† Instituto Madrileo de Estudios Avanzados en Nanociencias (IMDEA-Nanociencia), 28049 Madrid, Spain

‡ Condensed Matter Physics Center (IFIMAC), Universidad Autónoma de Madrid, 28049 Madrid, Spain.

Synopsis We investigate theoretically the origin behind the formation of the plateau and cutoff structures in the high-harmonic spectra produced after the interaction of a near-infrared laser pulse with a metal surface. We use a wave packet propagation scheme and a one dimensional description of the Cu(111) surface.

It has been demostrated that solid-state samples can be used as generators of high-order-harmonic (HHG) radiation. The interest of this phenomenon resides in the fact that HHG represents one of the most reliable way to generate coherent ultraviolet to extreme ultraviolet light, with the possibility to observe strong-field physics with modest laser-fields strengths, in contrast with atoms (see for example [1]).

Image-potential states are quantized electronic states that appear near the vacuum level and are present in metal surfaces containing a band gap. The coupling of these states with bulk electronic states is the key point to understand a variety of dynamical processes, as for example the desorption of adsorbates induced by electronic excitations [2]. We are interested in the theoretical description of high-order harmonic generation when electrons are trapped in such image states.

In this work we present a theoretical study of HHG from a Cu(111) surface, by using a quantum-mechanical model within the single-active-electron (SAE) approximation. For the description of this surface, we use a model potential reported by Chulkov *et. al.* in ref. [3]. The time-dependent Schrödinger equation is solved numerically on a one-dimensional grid of equidistant points in the position coordinate, where the time evolution of the electronic wave function is described with a modified version of the split-operator technique [4]. We investigate the formation of the plateau and cutoff as a function of the field intensity and the screening length. For example, Fig. 1 shows some results for a given intensity and two values of the screening length, corresponding to the penetration of laser field inside the material in one and two atomic layers.

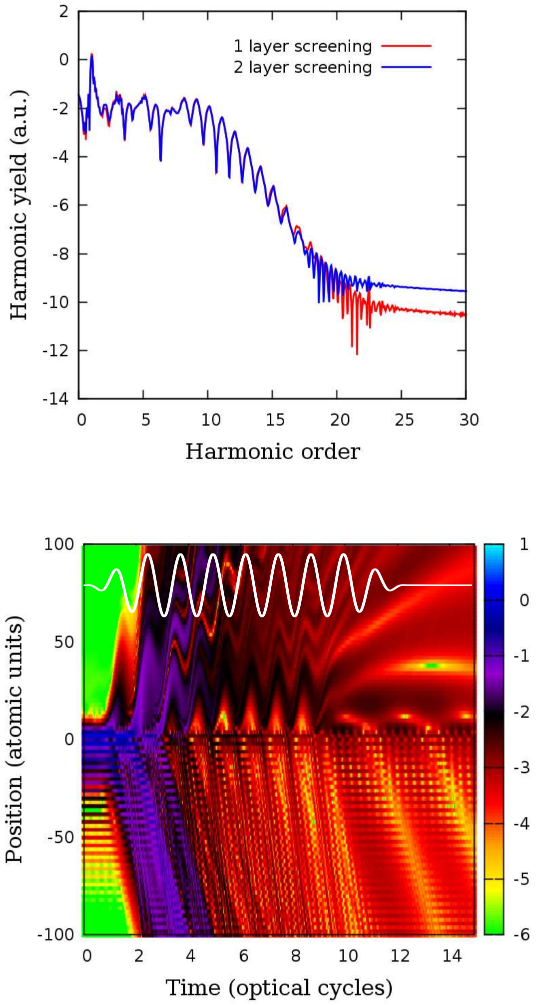

Figure 1. Top panel: harmonic spectra for a 1D Cu(111) surface irradiated by a 26.7 fs laser pulse (I_0 = 50 TW/cm^2, λ = 800 nm). Lower panel: time-dependent change in density on a log. scale.

References

[1] G. Wachter *et al* 2012 *Phys. Rev. B* **86** 035402

[2] J. Güdde *et al* 2006 *Chem. Rev.* **106** 4261

[3] E.V. Chulkov *et al* 1999. *Surf. Sci.* **437** 330

[4] C. M. Dion *et al* 2014. *Comput. Phys. Comm.* **185** 407

[1] E-mail: nestor.aguirre@uam.es