Impact of band structure on wave function dissipation in field emission resonance

S.M. Lu ,[1] W. B. Su ,[1] H. H. Chang,[1] H.T. Jeng ,[2,1,3]
W.Y. Chan ,[1] P.C. Jiang ,[1] K.H. Lin ,[1] and C.S. Chang[1]

[1]*Institute of Physics, Academia Sinica, Nankang, Taipei 11529, Taiwan*
[2]*Department of Physics, National Tsing Hua University, Hsinchu 30013, Taiwan*
[3]*Physics Division, National Center for Theoretical Sciences, Hsinchu 30013, Taiwan*

simonluyang@gmail.com

We demonstrated on Ag(111) and Ag(100) surfaces that the reciprocal of the field emission resonance (FER) linewidth, which is proportional to the mean lifetime of resonant electrons in FER, may vary with the electric field. The variation on Ag(111) was nearly smooth, whereas that on Ag(100) was sporadic and fluctuated remarkably. This drastic difference can be explained through their dissimilar projected bulk band structures and the ensemble interpretation of quantum mechanics, according to which all resonant electrons are governed by a single wave function (WF). Ag(100) has an energy gap above its vacuum level, whereas Ag(111) does not. Consequently, the dissipation rate of the WF, which is relevant to the FER linewidth, on Ag(111) was almost stable, whereas that on Ag(100) fluctuated. The fluctuation originated from the quantum trapping effect [1] and surface dipole layer (SDL) on Ag(100) surface. Through FER linewidth, we also demonstrated that SDLs of Cu(100) and Ag(100) are different. The authors are grateful for the support provided by the Ministry of Science and Technology and Academia Sinica, Taiwan.

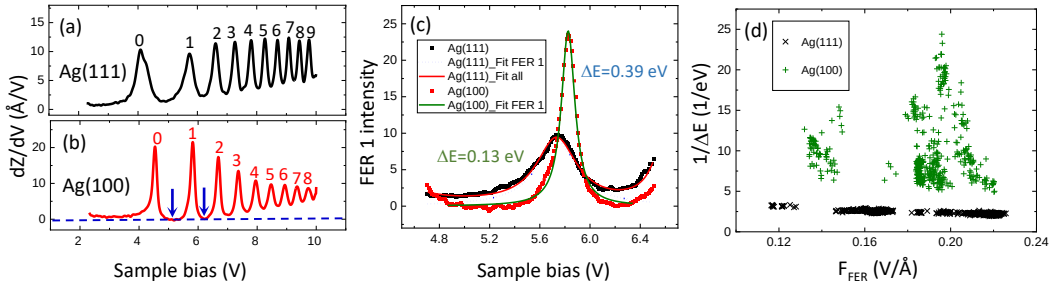

Fig.1 Typical field emission resonance (FER) spectra acquired on (a) Ag(111) and (b) Ag(100). The fitting linewidth ΔE of FER1 for the spectrum in (a) and (b) by Lorentz curve is shown in (c). (d) shows the electric field F_{FER} dependence of the reciprocal of ΔE on Ag(111) and Ag(100). This work has been published in Phys. Rev. B **105**, 195411 (2022).

[1] W. B. Su, S. M. Lu *et al*., Nanoscale Adv., **2**, 5848 (2020)