Comment on "Field-Emission Spectroscopy of Single-Atom Tips"

In a recent Letter [1], Binh *et al.* presented field electron energy spectra showing two distinct peaks separated by about 1 eV. The authors claim that their field emitters are single-atom tips and they attribute the observed peak structures to "...tunneling...through a *localized band structure* at the topmost atom." Shortly after the introduction of single-atom tips [2], which have since been shown to act as coherent point sources for low-energy electrons [3], several efforts were undertaken to measure the total energy distribution (TED) of the field-emitted electrons [4]. The energy spectra from single-atom tips, taken both with a retarding potential as well as with a hemispherical mirror analyzer, showed essentially the same features already known from experiments on ordinary [111]-oriented W tips [5], and were therefore not published [Figs. 1(a) and 1(b)]. These early results are compatible with more recent data obtained in Heidelberg [6] [Fig. 1(c)] and in Berlin [7]. In all these experiments TED's were typically taken with extraction voltages between 160 and 300 V. Different types of [111]-oriented tips have been examined: emitters terminating in more than ten atoms, as in Fig. 1(c) (curve in the middle), tips ending in a trimer, and also true single-atom tips, produced by depositing a single atom on the trimer. For a variety of different total currents (measured through the tip support) we observe single peaks with steep onsets at the Fermi level E_F. *No* significant features are detected in the energy range 2 to 1 eV below E_F, in contrast to the results of Binh *et al.*, who report very pronounced secondary features in this range. The structure of single-atom tips tested by us has been documented by detailed field ion microscopy (FIM) observations at each step [see for example FIM patterns in Fig. 1(c)]. For these emitters the electron energy distribution as measured with different analyzers in different laboratories has always shown the expected behavior. The startling results reported by Binh *et al.* therefore *cannot* be taken as characteristic of resonance tunneling through a single tungsten atom.

The work in Heidelberg was supported by the VW Foundation (AZ I/67344).

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Received 11 December 1992
PACS numbers: 61.16.Fk, 68.35.Fx

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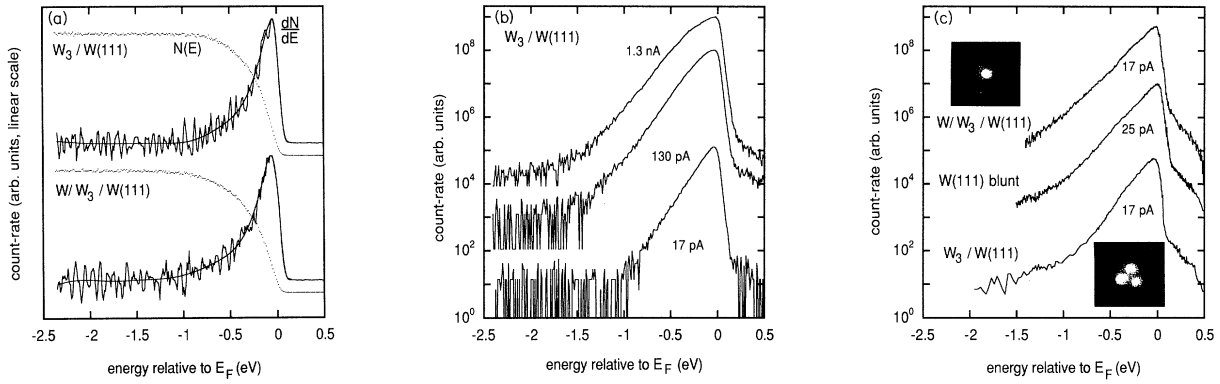

FIG. 1. Total electron energy distributions for ultrasharp [111]-oriented W tips. (a) Retarding potential analysis (Ref. [4]) gives $N(E)$ curves (dots) which were differentiated after data acquisition. No secondary peak structure was detected for emission from a tungsten monomer (lower data) nor for a tungsten trimer (upper data). (b) Hemispherical mirror analysis done in Rüschlikon (Ref. [4]). Data were taken for a W trimer on W(111) to demonstrate ordinary field emission behavior for a wide range of total currents. Spectra were shifted on the count-rate scale to avoid overlap between background signals. (c) Hemispherical mirror analysis done in Heidelberg (Ref. [6]). The TED curve in the middle was taken for a relatively blunt tip and serves as a reference.

