62 years after the first observation of individual molecules with the field emission microscope and prospective improvements for a single molecule microscopy

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The remarkable invention of the field emission microscope in 1936 by E. W. Muller enabled him some years later to turn it into a powerful instrument for imaging and characterizing individual molecules. He succeeded to report the first observations of organic molecules, namely phthalocyanine molecules, in 1950. Since then very few publications have been seen about this method of molecular characterization. For instance, the Cu_Phthalocyanine (Cu-Pc) molecule was observed in different configurations, namely two and four-leaf patterns, where these various apparent shapes were linked to the location of the molecule on particular atomic planes. Other investigations have been done for metal tips covered with such molecules, like field emission current (I-V) measurements. In fact, in these publications a group of individual molecules can be seen distributed randomly on a metal tip apex of 50-100 nm, which makes the analyses of a single molecule infeasible. Therefore, no quantitative investigations have been made to explain either the reason of the molecular appearance or the detailed mechanism of electron emission through a molecule. Currently, the development of new methods for fabrication of extremely sharp tips with an apex in the size of a single molecule provides a unique opportunity to study the behavior of one molecule, adsorbed on the tip apex, at a time. We briefly review some of the common methods for the fabrication of those extremely sharp tips with an apex in the range of 1 nm. We present preliminary data where two molecular adsorption states have been observed from the electronic cloud of a molecule: One arises from a very stable two-leaf pattern and the other case from a variable structure of single,

two, three and four-leaf configurations. As the atomic structure of the tip is identified from the field ion microscope the interaction of the molecule with surface atoms, and thus the adsorption and electronic states, can be readily modeled.