Covarage-tunable adsorption superstructure with high thermal stability: C_{60}/Cu(001)

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We have investigated C_{60} monolayer film growth and structure on Cu(001) with scanning tunneling microscopy at room temperature and 100 K. We discovered that the annealed equilibrium C_{60} adsorption structure depends sensitively on the initial deposition coverage; for a coverage less than 0.5 monolayer C_{60} orders in an one-bright-and-one-dim (1B1D) sequence of rows along the [110] direction, whereas for a coverage close to one monolayer C_{60} orders in a two-bright-and-one-dim (2B1D) sequence. At the transition region of the bright and dim row segments, C_{60} often appears “fizzle” at room temperature, indicating C_{60} adopts molecular orientation with in-equivalent symmetry. Upon heating, the C60 film irrespective of its structure exhibits high thermal stability before C_{60} fragmentation and desorption occur at ~800-900 K. The high thermal stability and coverage-dependent superstructure of the C_{60}/Cu(100) are unique among studied C_{60} monolayers on metals studied. We argue that different boundary energy of the 1B1D and 2B1D phases offers a plausible explanation on the observed tunability of superstructure versus coverage.