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The atomic-scale processes underlying nanoscale pattern formation on solid surfaces[1]

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The deposition of Pb atoms on Cu(111) produces two surface phases: a Pb-Cu surface-alloy and a Pb-overlayer. Within a specified range of Pb coverage, the two phases co-exist and spontaneously order into domain patterns with tens-of-nanometer periodicity[1]. The evolution of the domain structures with increasing Pb coverage agrees well with theoretical descriptions based on competing long- and short-range interactions. The system thus provides an ideal model system for probing the interactions underlying 2-D self-assembly. Although a self-consistent picture of the thermodynamic driving forces responsible for pattern formation now exists[2,3], a comprehensive understanding of the kinetic processes underlying self-assembly is only beginning to emerge. In this talk I will discuss recent experiments and calculations that address a key question concerning the kinetics of pattern formation: how do individual domains of each phase, which contain 10s of thousands of atoms, assemble into patterns on timescales of minutes? I will show that the self-assembly occurs by the collective motion of entire domains and present evidence that this motion is facile because (1) Pb atoms move quickly across the surface alloy due to Pb-Cu exchange and (2) Cu atoms move quickly *through* the overlayer phase due to a high concentration of vacancies and Cu atoms embedded within the overlayer. The latter finding is not intuitive and may explain why the remarkable pattern formation seen for Pb/Cu(111) has not been observed for other metal-metal systems. [1] R. Plass, *et al.*, Nature 412, 875 (2001). [2] R. van Gastel, *et al.*, Phys. Rev. Lett. 91, #55503 (2003). [3] R. van Gastel, *et al*, Phys. Rev. B (in press).

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