Abrikosov vortices in Nb thin films with Nb pillar arrays on top

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We experimentally investigate superconducting Nb thin films with arrays of circular and cross shaped Nb obstacles on top. The samples were fabricated from a single dc magnetron sputtered Nb film by a two step e-beam lithography process in combination with reactive ion etching. With this procedure we can vary the relative thicknesses of the film and the pillars as well as their size, shape and spatial arrangement. When a magnetic field is applied perpendicular to the film, Abrikosov vortices enter the scene. Due to their normal conducting core, these vortices experience the pillars as repulsive antipinning sites. Our system provides an easily tunable model for many body systems with repulsive interacting particles in a 2D potential landscape. We investigate the properties of the system by means of transport measurements, from which we deduce the critical current and the critical temperature, that is the complete $I_c(H) - T_c(H)$ phase boundary, in perpendicular magnetic fields H in the milli-Tesla range. We carry out our experiments at a variable temperature between the critical temperature T_c and $T = 4.2\,\mathrm{K}$ with a temperature stability $\Delta T < 1\,\mathrm{mK}$. We focus on commensurability effects between the pillar and vortex arrays and on dynamic trapping of vortices. Furthermore we are superimposing an HF alternating current of variable frequency and amplitude to the dc transport current. This allows us to search for and investigate possible phase-locking phenomena and absolute negative mobility.