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Probing vortex dynamics in YBCO nanowire using RF illumination

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Single photon detectors based on low temperature superconducting nanowires (SNSPD) have shown unmatched performance in terms of detection efficiency, count rate, jitter… and are currently commercially available.The possibility of achieving single-photon detection with high-temperature superconducting nanowires has been the subject of much theoretical work and intense debate, but there is no consensus in the community. This could reduce cooling efforts and thus enlarge a range of different applications of superconducting electronics. One way to achieve this is to fabricate ultra-thin nanowires whose superconducting properties are preserved in these materials that are easily degraded by standard nanofabrication techniques.
Transport properties of such devices strongly depend on the motion of Abrikosov vortices which is the aim of the current work.

We studied transport properties of thin (30 nm thick) YBCO nanowires in a wide temperature range under microwave illumination. We observe Shapiro-like steps. At low temperatures (below 50 K) in addition to an integer fractional Shapiro-like steps were observed. This phenomenon can be understood in terms of synchronized vortex motion as it was approached by Likharev and Yakobson using a non-sinusoidal current-phase relationship for vortex motion in nanobridges. Several samples also show negative dynamic resistance enhanced by microwave illumination. Taking into account YBCO film morphology and using the Time-Dependent Ginzburg-Landau framework we show how the formation of different vortex patterns can explain all observed effects and lead to an explanation of a multimodal switching current distribution that we measured on these samples at low temperature."

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