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Unconventional materials for superconducting-nanowire-based detectors

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During the last decade the investigation and development of superconducting-nanowires-based single photon detectors (SNSPDs) has become a very active area of low temperature detectors. Many basic experiments have demonstrated the fascinating potentialities of SNSPD in several fields.1 For long time NbN, and later NbTiN, have been the superconductors of choice for SNSPD. In the recent years the search for more appealing and performing superconductors, like WSi and MoSi 2,3 , has attracted the efforts of several groups and is presently a hot topic in this field. Another issue is represented by the detection mechanism in such detectors. While progress has been made in understanding several aspects of SNSPDs, many details of the detection mechanism are still unknown and currently, there is no consensus on the physical details of the working mechanism. The recent literature is assigning a relevant role to magnetic vortices both in the mechanism of the photo-response and fluctuations (i.e. dark counts).4,5 In this context, a strategy based on material hybridization of a superconductor with a ferromagnetic has the potentiality to open a new direction in the development of SNSPD. By introducing a weak ferromagnetic overlayer on top of pure NbN, one can envisage a control the vortex dynamics, which can be exploited to tune some property of the detector (dark counts, signal amplification) or enable fundamental investigations about the physical details of the working mechanisms and possibly differentiate between several proposed theoretical models.

We present results concerning the photoresponce and dark counts in hybrid NbN/NiC superconducting/ferromagnetic single nanowires with different thickness of the NiCu layer. Experiments under laser illumination in samples with low thickness of NiCu show signature of single-photon response. At increasing thickness of the ferromagnetic layer we observe a significant increase of the superconducting critical current density which confirms previous investigations4 and a significant decrease of dark counts. It was possible to perform a comparison of dark counts in hybrid NbN/NiC and pure NbN nanowires. The results are explained in terms of the existing models based on the presence of magnetic vortices.6 The data analysis allows to discriminate between the

various models, giving the possibility to infer more about the intriguing debate on the physical origin of dark counts.

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