Electrical Characteristics of Superconducting-Ferromagnetic Transistors

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Abstract — We report experimental results on characteristics of SFIFS junctions and multi-terminal SFIFSIS devices (where S, I, and F denote a superconductor (Nb), an insulator (AlO_x), and a ferromagnetic material (Ni), respectively). The SFIFS junctions serve as injectors in the SFIFSIS devices which have transistor-like properties; for this reason we call them Superconducting-Ferromagnetic Transistors (SFTs). We have found the F (Ni) thickness at which the SFIFS current-voltage characteristic (CVC) becomes linear. Furthermore, we investigated the DC and AC characteristics of SFTs of two types: ordinary devices with a single acceptor (SIS) junction, and devices with a double acceptor. In the first case, we focused on studying the influence of the injection current through the SFIFS junction on the maximum Josephson current of the SIS acceptor. For devices of the second type, we studied voltage amplification properties when the operating point was chosen in the sub-gap region of the acceptor CVC. By applying an AC signal (in the kHz range) while biasing the injector (SFIFS) junction with a constant DC current, we observed a voltage gain above 25 on the double acceptor. In the reverse transmission experiment, we applied DC current and an AC modulation to the acceptor junction and, within the accuracy of the experiment, observed no response on the injector junction, which implies an excellent input-output isolation in our SFIFSIS devices. The experiments indicate that, after optimization of the device parameters, they can be used as input/output isolators and amplifiers for memory, digital, and RF applications.

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