The effect of voltage on reservoir computing performance of a spin torque oscillator

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Spin torque oscillator (STO) driven by highly nonlinear motion of magnetization can generate transient dynamics, which can be useful to realize physical reservoir computing [1-3]. Using an STO for the reservoir computing, high recognition rate was achieved in spoken digit recognition. [4] As a figure of merit of the reservoir computing, memory capacity C_{STM} is widely used, which can be estimated from short-term memory task. [3] In the task, a random pulse sequence was given to the reservoir as input (duration of a unit pulse Δt). The transient behavior of the reservoir was analyzed to extract the information of the input. We evaluated C_{STM} of STOs in both simulation [5] and experiment [6]. In the simulation the optimum Δt at which C_{STM} exhibits a maximum was about one third of the transient time of the STO. Experimentally the transient time of the STO decreased with increasing the pulse voltage V_{int} [7]. Therefore, it is expected that the optimum Δt at which C_{STM} exhibits a maximum decreases at a high voltage and increases at a low voltage. In other words, the memory capacity will exhibit maximum at high (low) pulse voltage V_{int} when the pulse duration is short (long). In this study, we performed systematically the short memory task to evaluate the memory capacity in vortex-STO as functions of pulse duration and voltage. In the task, random binary input pulses were given to the STO. Virtual nodes (>100) were defined in one pulse. A product-sum operation of the output (STO voltage) and weights (controlled) at the nodes was performed to reconstruct the input signal (see details in Ref. 6). Figure 1 shows the V_{int} dependence of C_{STM} with the various Δt. A maximum of the memory capacity shifts from high to low V_{int} as Δt increases, which is consistent with our expectation.

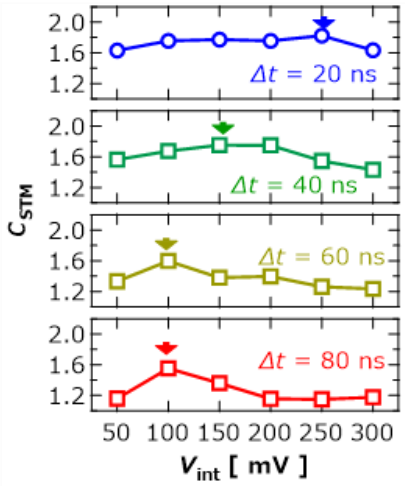

Fig. 1 Pulse voltage V_{int} dependence of memory capacities C_{STM} with various pulse duration Δt. The arrows indicate the V_{int} where the C_{STM} reached the maximum.

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