1/*f* noise analysis of 2D material-based transistors on paper

L. Pimpolari[1]
G. Calabrese[1], S. Conti[1], R. Worsley[2], S. Majee[2], D. K. Polyushkin[3], M. Paur[3], G. Iannaccone[1], M. Macucci[1], T. Mueller[3], C. Casiraghi[2], G. Fiori[1]
[1]Dipartimento di Ingegneria dell'Informazione, University of Pisa, Pisa, Italy
[2]Department of Chemistry, University of Manchester, Manchester, UK
[3]Institute of Photonics (TU Wien), Vienna, Austria
lorenzo.pimpolari@ing.unipi.it

Atomically thin films of MoS_2 have emerged as promising building blocks for flexible electronics. Recently, we reported high-performance CVD-grown MoS_2 field effect transistors (FETs) on paper with inkjet-printed Ag contacts and h-BN dielectric [1]. Here, for the first time, we study the low-frequency noise (LFN, or 1/*f* noise) behaviour on the same devices, which can provide useful insights on the physical mechanisms at play in the fabricated FETs. Fig. 1 (a) shows a photograph and an optical micrograph of a fabricated FET. A typical FET transfer characteristic is shown in Fig. 1 (b). LFN is expressed using Hooge's law: $S_{I_{DS}} = A\, {I_{DS}}^2/f^{\gamma}$, where $S_{I_{DS}}$ is the power spectral density (PSD) of the channel current (I_{DS}), A the noise amplitude, and f the frequency. The PSD and the normalized PSD of I_{DS} for different drain voltages (V_{DS}) are shown in Fig. 1(c), and its inset, respectively. In the latter, the spectra nearly overlap, indicating a good normalization. Fig. 2 (a) shows the PSD of I_{DS} for different gate voltages (V_{GS}). The dependence of $1/A$ and γ (the exponent of f) on V_{GS} is reported in Fig. 2 (b). The linear fit of $1/A$ suggests that mobility fluctuations are at the origin of the observed noise, in agreement with the Hooge model, and γ~1. Finally, Fig. 2 (c) shows the Hooge parameter $\alpha_H = A \cdot N$, where N is the total number of carriers in the channel. This parameter is comparable with those of mechanically exfoliated monolayer MoS_2 FETs [2].

References

[1] S.Conti et al., arXiv:1911.06233v1
[2] V. K. Sangwan et al., Nano Letters (2013)

Figures

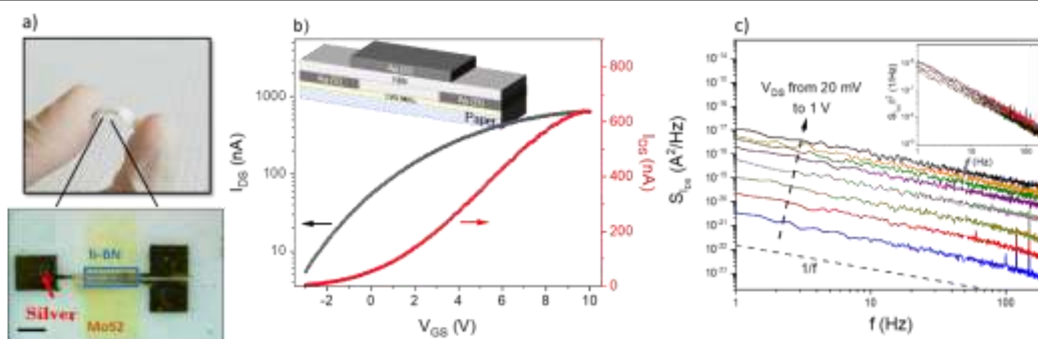

Figure 1: (a) Optical image of the paper substrate and of a FET (scale bar: 200 µm). (b) Transfer characteristic of a studied FET. Inset: Schematic image of the device. (c) PSD of the channel current for V_{DS} from 20 mV to 1 V, with V_{GS} = 6 V. Inset: normalized PSD with respect to the current.

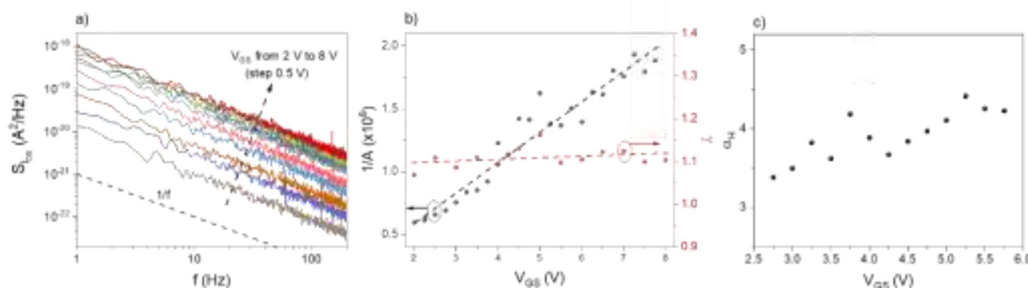

Figure 2: (a) PSD of the channel current for V_{GS} ranging from 2 V to 8 V, with V_{DS} = 1 V. (b) Noise amplitude (left axis) and exponent of the frequency (right axis) as a function of gate voltage. (c) Hooge parameter as a function of V_{GS}.