Resistive switching induced by an electronic avalanche phenomenon in the narrow gap Mott Insulators GaM_4Q_8 (M = V, Nb, Ta ; Q = S, Se)

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The narrow gap Mott insulators GaM_4Q_8 (M=V,Nb,Ta ; Q= S,Se) exhibit very interesting electronic properties when pressurized or chemically doped [1]. We have recently discovered that the application of short electrical pulses on these compounds induces a new phenomenon of volatile or non-volatile resistive switching [2]. The volatile transition appears above threshold electric fields of a few kV/cm, while for higher electric fields, the resistive switching becomes non-volatile. All our results indicate that the resistive switching in the AM_4Q_8 compounds does not match with any previously described mechanisms based on joule heating or electrochemical phenomena [3]. Conversely, our recent work shows that the volatile resistive switching is related to an electric field triggered electronic avalanche phenomenon [4]. This avalanche breakdown induce the collapse of the Mott insulating state at the local scale and ultimately lead to the formation of a granular conductive filament formed by compressed metallic domains and expanded “superinsulating" nanometric domains [5]. In the non volatile regime, the application of successive very short electric pulses enables to go back and forth between the high and low resistance states. This reversible resistive switching was observed down to 30 nm using an STM tip [5], or on metal-insulator-metal (MIM) devices made of thin layers of GaV_4S_8 which proves the high potential of this new class of Mott-memories for applications [6].

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