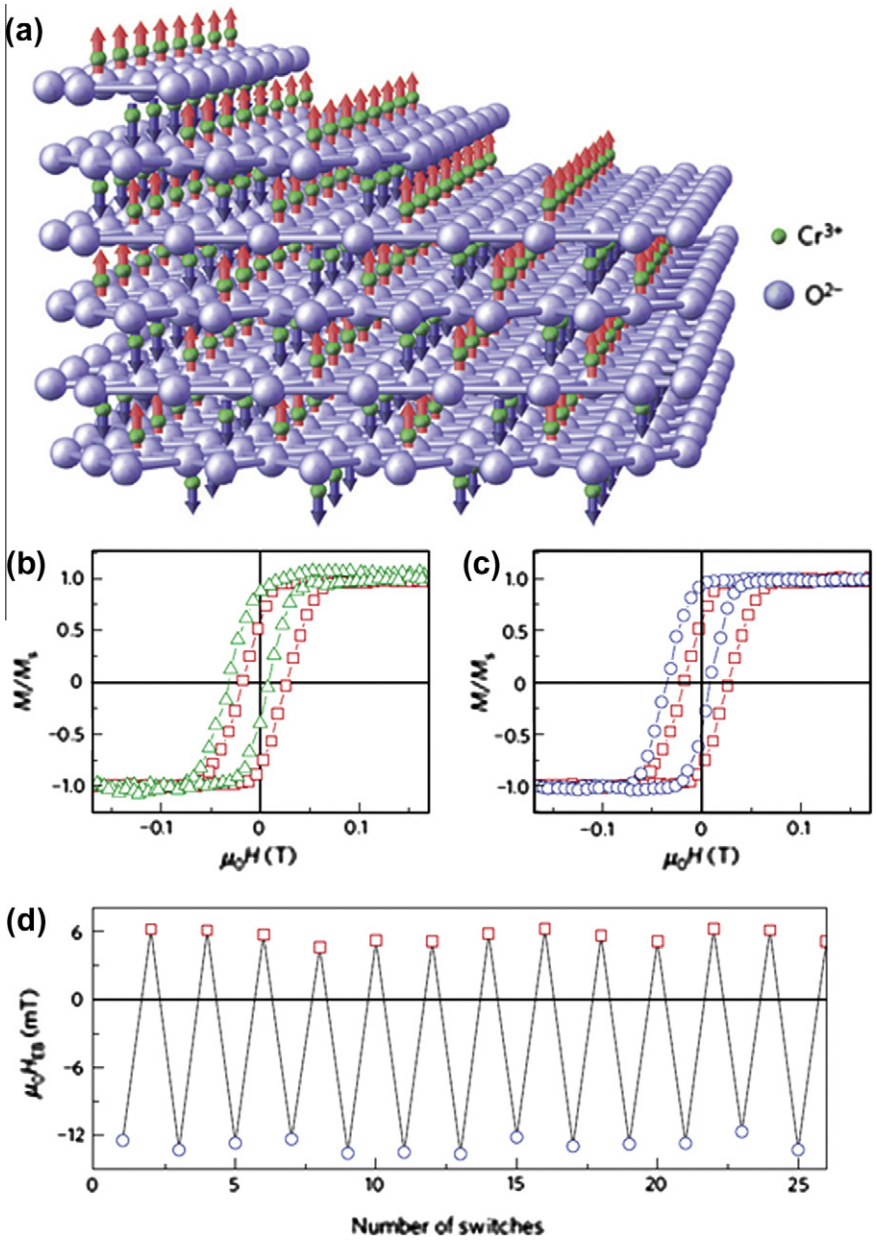

Fig. 16. Electric field control of magnetism with Cr_2O_3. (a) The spin structure of a Cr_2O_3 single crystal with a terraced (0001) surface is shown for one of its two antiferromagnetic single-domain states. Up (red) and down (dark blue) spins of the Cr^{3+} ions (green spheres) point along the c axis. (b) Exchange-biased hysteresis loops of Cr_2O_3 (0001)/Pd 0.5 nm/(Co 0.6 nm/Pd 1.0 nm)$_3$ at $T = 303$ K after initial magnetoelectric annealing in $E = 0.1$ kV mm^{-1} and $H = 77.8$ mT. Hysteresis loops are measured by polar Kerr magnetometry at $E = 0$. The red squares show the virgin curve with a positive exchange-bias field of +6 mT. Isothermal-field exposure in $E = -2.6$ kV mm^{-1} and $H = 154$ mT gives rise to a loop with a negative exchange-bias field of −13 mT (green triangles). (c) The red squares show the same virgin reference loop. The blue circles show the hysteresis loop after isothermal-field exposure in $E = 2.6$ kV mm^{-1} and $H = -154$ mT, giving rise to the same negative exchange bias of −13 mT. (d) Exchange bias field vs. number of repeated isothermal switching through exposure to $E = 2.6$ kV mm^{-1} (blue circles) and -2 kV mm^{-1} (red squares) at constant $H = -154$ mT, respectively (adapted from Ref. [134]). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

to note that although ferroelectric random access memories (FeRAMs) have achieved fast access speeds (5 ns) and high densities (64 Mb) in a number of different materials, they remain limited by the need for a destructive read and reset operation. The appeal of multiferroics is that they offer the possibility of combining the best qualities of FeRAMs and MRAMs: fast low-power electrical write operation, and non-destructive magnetic read operation. At the 256 Mbit level, such memory devices [137] would be a "disruptive technology" and could eliminate competition such as EEPROMs (electrically erasable programmable read-only memories) for applications including megapixel photo-memories for digital cameras or audio memories in devices such as mp3 players. It is fair to state, however, that work