NANOSCALE FERROELECTRICITY IN CRYSTALLINE GLYCINE

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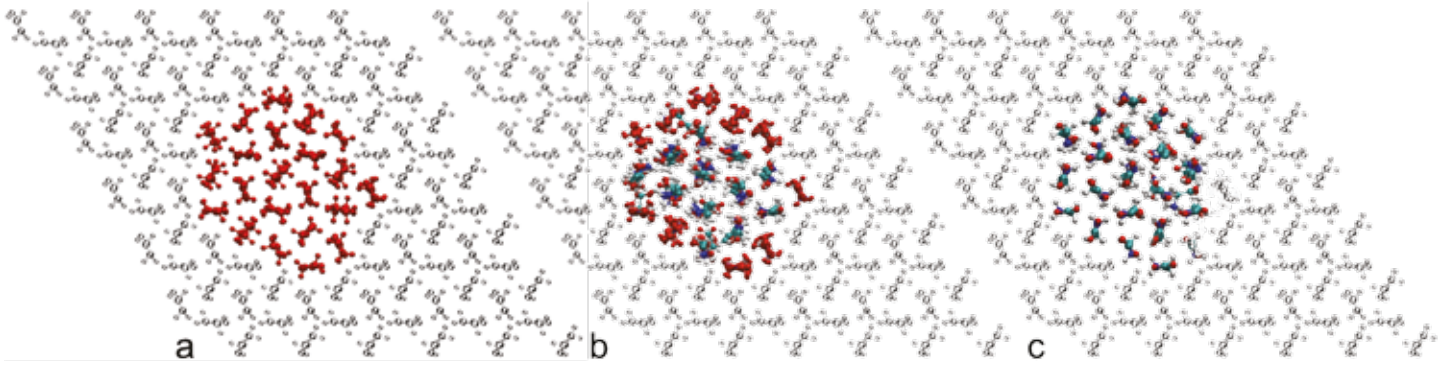

Ferroelectrics are multifunctional materials that reversibly change their polarization under an electric field. Recently, the search for new ferroelectrics has focused on organic and bio-organic materials, where polarization switching is used to record/retrieve information in the form of ferroelectric domains. This progress has opened a new avenue for data storage, molecular recognition, and new self-assembly routes. Crystalline glycine is the simplest amino acid and is widely used by living organisms to build proteins. In this work, it has been shown for the first time that γ- glycine, which has been known to be piezoelectricsince 1954, is also a ferroelectric , as evidenced by local electromechanical measurements and by the existence of as-grown and switchable ferroelectric domains in microcrystals grown from the solution (Fig. 1). The experimental results have been rationalized by molecular simulations that establish that the polarization vector in glycine can be easily switched on the nanoscale level under the moderate electric field (Fig. 2). The discovery of ferroelectricity in amino acids offers new pathways to novel classes of bioelectronic logic and memory devices, where polarization switching is used to record and retrieve information in the form of ferroelectric domains. This ferroelectric-based memory can be built, for example, using the synergy with DNA-based conductors and organic transistors. Beyond information storage, these studies open up a set of interesting possibilities regarding the role of glycine piezoelectricity and ferroelectricity in the genesis of life (e.g., protein formation), as well as emerging properties in peptides from the biophysical point of view.

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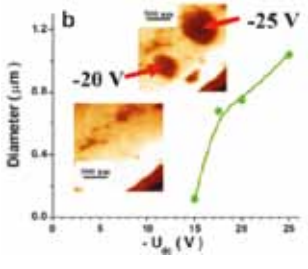

FIGURE 1
(a) As-grown ferroelectric domains in glycine, (b) Polarization switching (shown by arrows) after application of moderate electric field.

FIGURE 2
Molecular switching of glycine molecules under increasing bias field: (a) 0.434, (b) 4.10 and (b) 9.55 V/nm