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EFFECT OF OXYGEN DOPING ON THE PHASE TRANSITION TEMPERATURE OF $CuInP_2S_6$ CRYSTALS

Alexander Molnar*, Dávid Gál **, Henrietta Bán*

** Uzhhorod National University, Department of the Physics of Semiconductors, Ukraine,*
e-mail: alexander.molnar@uzhnu.edu.ua
*** HUN-REN WIGNER Research Centre for Physics, Budapest 1121, Hungary,*
e-mail: galdavidagu7@gmail.com

The effect of oxygen enrichment of $CuInP_2S_6$ layered crystals is discussed. It is shown that the addition of oxygen during the growth of these single crystals allows the rise of the phase transition temperature by 20 degrees (up to 336K). Since the relatively low phase transition temperature of these materials is one of the limiting factors in their practical application, this solution (which is widely used in the semiconductor industry), allows to significantly improve the prospects for the use of $CuInP_2S_6$ as a gate dielectric for negative capacitance FET transistors (NC FET) and ferroelectric memory cells.

Recently, there has been an increased interest in two-dimensional layered crystals with multiferroic properties. Among them are $CuInP_2S_6$ crystals, in which ferroelectric properties are observed at room temperature, and they remain stable even when the active layer thickness is reduced below 4 nm [1]. This property makes it a promising candidate for use as a sub-gate dielectric layer (to create field-effect transistors with negative capacitance to improve subthreshold swing) and as an active material for creating small-sized ferroelectric memory cells.

One of the few disadvantages of $CuInP_2S_6$ crystals is the relatively low Curie temperature of 315K, which limits the temperature range of using devices based on it. To overcome this limitation, two solutions are currently known: using crystal compression, which leads to an increase in the phase transition temperature [2], or growing stoichiometrically deviated samples with an increased amount of indium [3], which leads to similar results.

We found another possibility to increase the phase transition temperature of $CuInP_2S_6$ crystals. When studying the temperature dependence of the dielectric permittivity of these crystals enriched with oxygen, we observed an increase in the Curie temperature by 20 degrees (336K). Since oxidation is a standard method in the semiconductor industry, the observed phenomenon can be utilized in designing future devices using $CuInP_2S_6$ layered ferroelectrics to increase their temperature range.

References

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