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Piezoelectricity of 2D Heterobilayer Systems

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Category
Semiconductors/Devices & Components
Materials Science & Nanotechnology/Advanced Functional Materials

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Researchers at Purdue University have developed a piezoelectric material system. This technology helps semiconductor device engineers and designers create field or mechanical stress sensitive nanodevices, amplifiers, or sensors. Equipped with a material adjustment mechanism, the system can be selectively operable to adjust the user-specified material condition for altering the collective material property. Unlike traditional 3D material-based piezoelectric structures that need large fields and mechanical distortions to operate, this technology requires only small mechanical changes. Moreover, the system can integrate the changing of static charge separation into any existing structure or device.

Technology Validation:

High-precision manufacturing techniques, advanced lithography and alignment tools were used to evaluate the effectiveness of the proposed piezoelectric material system. After conducting experiments by shifting the interlayer spacing upwards and downwards by 10% and 30%, respectively, it was concluded that nonlinearity was changed by e33 with respect to the interlayer shift. Further, the absolute value increased tenfold in comparison with the equilibrium distance.

Advantages:

-Increased efficiency

-Broad application range

Applications:

-Sensitive pressure / touch sensors

-Piezoelectric transistors

-Multi-quantum-well light-emitting diodes

-Active feedback control systems

-Actuators

-Energy harvesters

-Transducers

Publication:

Hsiao, H. Narendra, N., & Kubis, T. (2024) Long range piezoelectricity effects in van der Waals heterobilayer systems beyond 1000 atoms. Journal of Physics: Condensed Matter, 36(26), 25901. https://doi.org/10.1088/1361-648x/ad3708

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Intellectual Property:

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Keywords: Piezoelectric material system,Field-sensitive nanodevices,Mechanical stress sensors,Material property modulation,Low-strain activation,Piezoelectric transistors,Van der Waals heterobilayers,Energy harvesting devices,Nonlinear charge separation,Semiconductor device integration