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Strain wave induced electron transport in superlattices

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We show that propagating high-amplitude coherent strain pulses, generated by ultrafast optical excitation of a metal film can induce a charge current in a GaAs/AlAs superlattice (SL). The studied SL had a period of of 12.5 nm and a miniband width of 12 meV. It was grown by MBE on a 0.35 mm-thick semi-insulating GaAs substrate, and a 100 micron device MESA fabricated. On the other side of the substrate a 100 nm-thick Al film was deposited. A coherent picosecond strain pulse was generated opposite the device by exciting the Al film with 40 fs, 800 nm pulses from a 5 KHz, 2.5 mJ Ti:Sapphire amplifier. A strong current pulse from the device was observed about 80 ns after the laser pulse was incident on the Al film, this time delay being equal to the time of flight of longitudinal polarized strain pulses across the GaAs substrate. We attribute the current pulse to electrons that are confined and dragged along by the potential generated by the strain wave. Theoretical calculations show that this "wave dragging" effect in the presence of the SL potential can give rise to the generation of ultra-high (THz) frequency electron dynamics.