

Graphene Breakthroughs

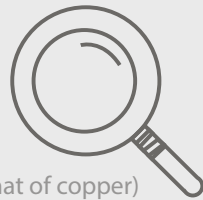
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bt discovery

1st two-dimensional (2D) atomic crystal discovered (2004)
Nobel Prize in Physics for its discovery (2010)
groundbreaking properties possessed
family of many 2D materials exists
properties can be extended by doping and forming
heterostructures with other 2D materials

bt properties



current density (> million times that of copper)
elastic constant (extremely high)
electrical and thermal conductivity (very high)
electron mobility (highest at room temperature)
intrinsic strength (130 GPa, 200 times that of steel)
optical absorption (2.3 %)
sheet resistance (30 Ω per)
Young's Modulus (1 TPa)

readily chemically functionalized
impermeable to all gases (but allows water to pass through)

2

4



bt potential

conductive inks and transparent electrodes
energy storage
flexible electronics and wearables
high-speed electronics
lithium-ion batteries
membrane & separations technology
sensors for bioapplications and magnetic fields
spintronics & plasmonics
touch screens

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bt production

mechanical exfoliation ('sticky tape' method)
chemical vapor deposition (CVD) on metal substrates
liquid-phase and thermal exfoliation
synthesis on silicon carbide
graphite to graphite oxide to graphene



bt reality

graphene-enhanced polymer Graphene XT
tennis racket (Head)
graphene-based ultracapacitors (Skeleton Technologies)
graphene-composite bicycle wheels (Vittoria)