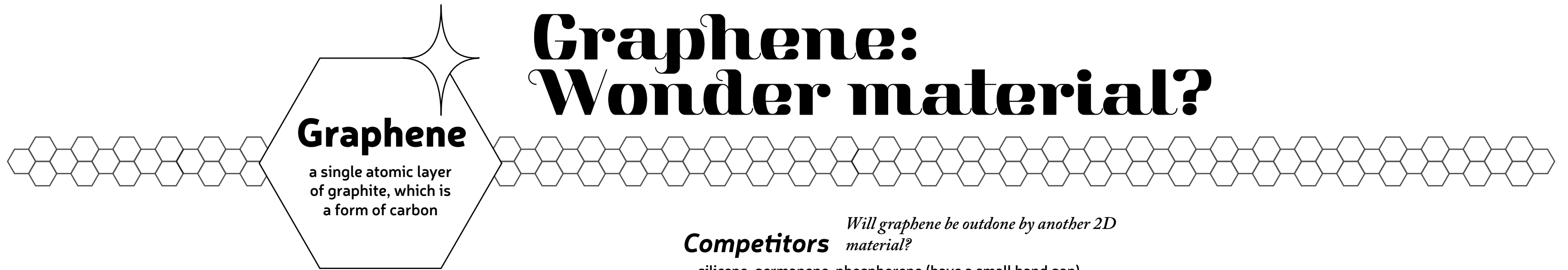


# Graphene: Wonder material?



## Properties

Strong—200x stronger than steel  
Hard—harder than diamond  
Flexible—as flexible as rubber  
Thin & lightweight  
Almost transparent

### Catalyst

susceptible to oxidative environments

Can be hydrophobic or hydrophilic  
Impermeable  
Conducts heat  
Conducts electricity

### No band gap

Never stops conducting—electronic applications are limited

Magic  
↳ Alchemy  
↳ Enlightenment+science

## History

- 1947** possibility of graphene first posed by Canadian physicist Philip Wallace while studying graphite
- 2004** academics from the University of Manchester, Andre Geim and Kostya Novoselov, isolated graphene for the first time from a lump of graphite by using sticky tape
- 2004 onwards** global explosion into the study of graphene and its potential uses

“The potential of graphene is limited only by imagination!”  
*Who does this benefit?*

## Competitors

*Will graphene be outdone by another 2D material?*

silicene, germanene, phosphorene (have a small band gap)  
stanene (tin)

## Research

Focused on benefits of graphene  
Limited funds for health and environmental impacts research

## Creation

Natural—from graphite  
Synthetic—e.g. from honey  
2 main methods:  
Exfoliation  
Growth on surfaces

Some toxic prep methods  
energy intensive methods

## Sustainability

Recyclable  
Biodegradable  
Non-renewable resource  
Feasibility of recycling

## Supply

Demand could exceed supply  
Price volatility  
China dominates 70% of market

## Applications

### Current

Paints and inks  
Sports equipment  
Touchscreens

### Potential

Ultrafiltration  
Energy storage  
Electric cars  
Wearable technology  
Optical electronics  
Semiconductors  
Biological engineering  
Anti-cancer medication

Potential for harmful deposits in the body

*Where do development dollars go—applications such as ultrafiltration of water for the developing world or Western luxury items?*

*Will the benefits outweigh the costs?*



**uncertain future**

Could all be a waste of billions of dollars

Currently unable to produce commercially viable quantities

## Redirective futures

Shift in material thinking—our material cultures

*Do we need new materials or should we design better with the ones we already have?*

### Ban use

← unmanageable

Manage risks

← unsafe

Study long-term effects

← safe

Research cons thoroughly as well as pros

**Apply to products in order of worthiness and usefulness**

# Graphene: Wonder material?

# Or the new asbestos?

Graphene

single atomic layer of graphite, which is a form of carbon

## Properties

- Strong—200x stronger than steel
- Hard—harder than diamond
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- Thin & lightweight
- Almost transparent

### Catalyst

susceptible to oxidative environments

- Can be hydrophobic or hydrophilic
- Impermeable
- Conducts heat
- Conducts electricity

### No band gap

Never stops conducting—electronic applications are limited

## Discovery

late 1800s

Commercial use (during the Industrial Revolution)

*“The wonder material!”*

1917  
2004  
2004 onwards

Magic  
↳ Alchemy  
↳ Enlightenment+science

“The potential of graphene is limited only by imagination!”

*Who does this benefit?*

## Competitors

Will graphene be outdone by another 2D material?

silicon, germanene, phosphorene (have a small band gap)

stanene (tin)

## Research

Deadly consequences overlooked

Research proves graphene is toxic to humans

studies suggest may cause cancer-like asbestos

Biodegradable

Non-renewable resource

Feasibility of recycling

Supply

Demand could exceed supply

Price volatility

China dominates 70% of market

## Widespread Application

- Fireproofing
- Construction materials
- Cement
- Insulation
- Pipes
- Brake lining
- Appliances & toys

Where do development dollars go—applications such as ultrafiltration of water for the developing world or Western luxury items?

## Consequences

Multitude of health problems, many deaths worldwide  
Waste of resources including time and money

1970s onwards

Bans in much of the developed world, although alarmingly not in the US

## Redirective futures

*“Those who fail to learn from history are doomed to repeat it.”*

Do we need new materials or should we design better with the ones we already have?

Shift in material thinking—our material cultures

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