



# ENGINEERING CHEMISTRY

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Department of Science and Humanities



# ENGINEERING CHEMISTRY

## Functional materials-Polymers

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### *Class content:*

- *Polymer Composites*
  - *Kevlar*
    - *Synthesis*
    - *Properties*
    - *Applications*
  - *Reinforced Kevlar composites*

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### Polymer composites

- Materials made from **two or more constituent materials** and their properties are not attainable by any individual component alone are called composites
- When **one or more of the components are polymers** they are called polymer composites
- Two components are **fibre** and **matrix**
  - matrix:** polyester, epoxy, phenolic, silicone, melamine, vinyl derivatives
  - fibers:** glass fiber, boron filaments, carbon/graphite fibers, aramid (aromatic polyamide), aluminum fiber
- Polymer composite are produced by suitably bonding a fiber material with a polymer resin matrix and curing the same under pressure and heat
- Composites **have high strength / unit weight**



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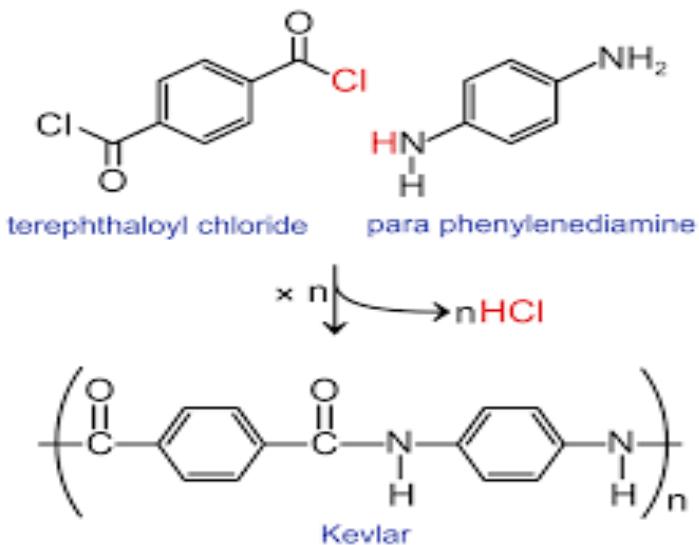


### Kevlar

- An **aramid fibre** - Aromatic polyamide
- Chemical name is **poly-paraphenyleneterephthalamide**

### Synthesis :

- Condensation of 1,4 phenylene diamine and 1,4 benzenedicarbonyl chloride

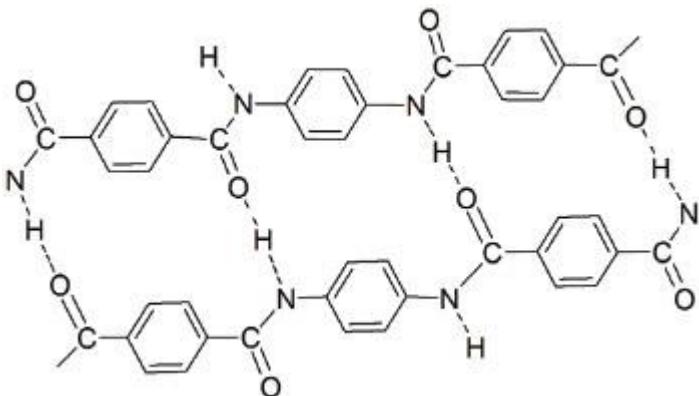


Source:<https://mccord.cm.utexas.edu/chembook/page-nonav.php?chnum=8&sect=6>

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- Kevlar is very strong material – about **5 times stronger than steel**
- High strength is due to:
  - Many inter chain **hydrogen bonds**. The inter-molecular hydrogen bonds formed between the carbonyl groups and NH centers



Source:[https://www.scielo.br/scielo.php  
?script=sci\\_arttext&pid=S1516-  
14392014000500012](https://www.scielo.br/scielo.php?script=sci_arttext&pid=S1516-14392014000500012)

- Additional strength is derived from **aromatic stacking** interactions between adjacent strands



Source:<https://www.nanowerk.com/nano-technology-news2/newsid=52521.php>

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### Properties :

- High tensile strength, high modulus of elasticity
- High strength to weight ratio
- High chemical inertness
- Low co-efficient of thermal expansion
- Flame resistance
- High impact and cut resistance
- Textile processibility

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### Applications :

- Well known component of personal armor such as combat helmets, ballistic face mask and ballistic vest, bullet proof vest
- Gloves, sleeves, jackets and other articles
- Inner lining in bicycle tires
- Light weight boat hulls, aircraft panels, race cars, bridge structure,
- Roto blades, tennis, cricket bats, and hockey sticks
- Fiber is used in woven rope and in cable
- As reinforcement in car tires, in car brakes
- In the strings of archery bows

### Disadvantages:

- Special cutting scissors and drilling machines are required
- The fibre is hygroscopic- they absorb moisture

### Reinforced Kevlar composites

- Kevlar composite is made by combining **Kevlar fibre with epoxy resin**
- **Applications :**  
monocoque bodies of F1 racing cars, helicopter rotor blades, kayaks, tennis and squash rackets



**THANK YOU**

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