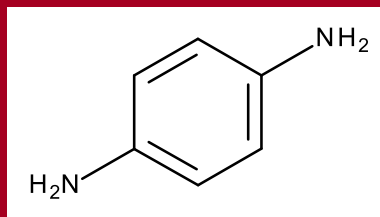


Para-phenylenediamine (PPD)

Molar Mass : 108.14 g mol⁻¹

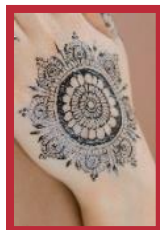
Melting point : 145-147°C



PPD is a colourless solid compound. On exposure to air, over a period of time, it darkens or forms colored compounds due to multiple reactions involving aerial oxidation and coupling.

In 1909, a French Chemist Eugène Schueller prepared the first hair dye using PPD and began selling it to hair dressers. In the same year he founded a cosmetics company, which was to become the L'Oréal group.

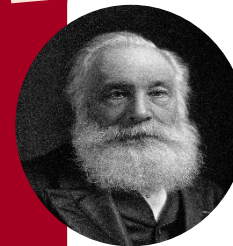
Do you know?



The black substance, often sold as naturally occurring henna stone in some of the Asian and African countries is oxidized PPD. Black henna tattoos also contain PPD.

Invention of PPD

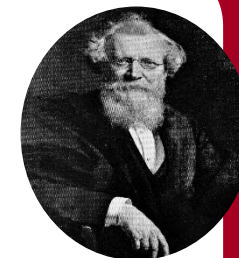
William Henry Perkin



German chemist August Hofmann was the first director of the Royal College of Chemistry, London (now part of Imperial College London). In the year 1856, he assigned his student, William Henry Perkin the task of synthesizing quinine, for the treatment of Malaria.

Perkin's experiments using aniline failed to produce the desired product but while cleaning a flask used for this experiment, then 18 year old Perkin accidentally discovered a purple pigment. He named the pigment Mauvine and later it became one of the first synthetic dyes to be mass-produced.

Eventually, Professor August Hofmann also started working with Mauvine and derived a new compound PPD, in 1863, which later became a crucial component of most oxidative hair dyes.



August Hofmann

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<https://chem.hbcse.tifr.res.in/>

PPD in hair colours



Components of oxidative hair dyes can be classified under three categories- developers, oxidants and couplers. PPD falls under the first category i.e. developers or primary intermediates.



Oxidants like hydrogen peroxide are used in hair colours to bleach the hair and strip off the original dark colour. These also oxidize the PPD and gives rise to reactive species.



These reactive species reacts with the couplers. The couplers used in this reaction determine the colour of the dyed hair.

Harmful effects of PPD



PPD is a common allergen that causes skin allergies. The allergic response is often observed few hours to few days after the exposure. Hence, patients find it difficult to identify the allergen. PPD is poisonous if ingested and is banned in some places.



a. Stephanie Kwolek

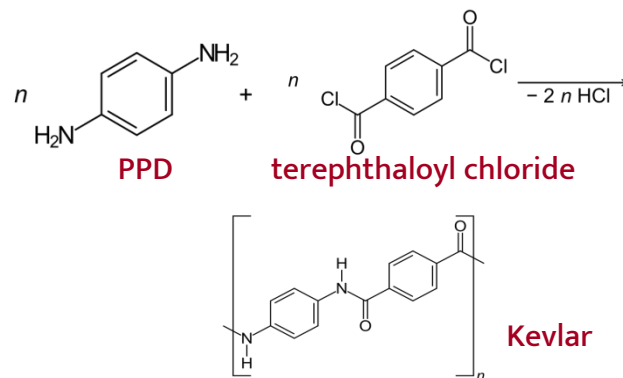


b. Pieces of a Kevlar helmet used to help absorb the blast of a grenade



c. Kevlar armor in superhero movies.

In 1965, an American chemist Stephanie Kwolek invented an exceptionally strong polymer called Kevlar. It is the product of a chemical reaction between PPD and terephthaloyl chloride. Today, Kevlar has various applications especially in the manufacturing of combat helmets and bullet proof jackets used by the military.



Asia-Pacific region is considered to be a growing market for PPD due to its applications in cosmetics, rubber & plastic manufacturing. There has been a rise in such industries in Asian countries like Japan, India, China etc. High population in Asian countries also builds a strong customer base for these items.

Other applications of PPD

PPD and PPD like chemicals are used to increase the durability of plastic and rubber products. It is used as an anti-ozonant in manufacturing of tyres to prevent the damages caused by ozone.



PPD is used in developing photographic films. It is also used in printer inks and ball pen inks. Dermatologists use PPD in patch test to identify allergens.

References and Further Reading

1. The Chemistry of Permanent Hair Dyes. (2018, March 16). Retrieved on May 5, 2020, from <https://www.compoundchem.com/2015/05/14/hair-dyes/>
2. Olivier J. X. Morel and Robert M. Christie, (2011) Current Trends in the Chemistry of Permanent Hair Dyeing, *Chemical Reviews* 111(4), 2537-256
3. Kabir R. B.& Ferdous N., (2013). Kevlar-The Super Tough Fiber. *International Journal of Textile Science*, 1(6), 78–83. <https://doi.org/10.5923/j.textile.20120106.04>

Image sources- Accessed in April, 2020

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Now, can you find?

1. Why are components of commercial hair colours packed in separate packets?

For more questions, refer Indian National Chemistry Olympiad questions 2020 paper: Problem 1-<https://olympiads.hbcse.tifr.res.in/>

