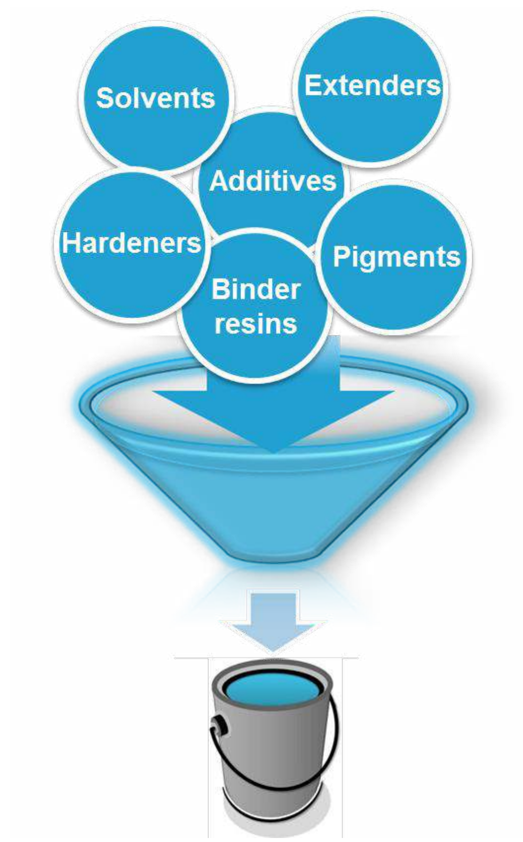
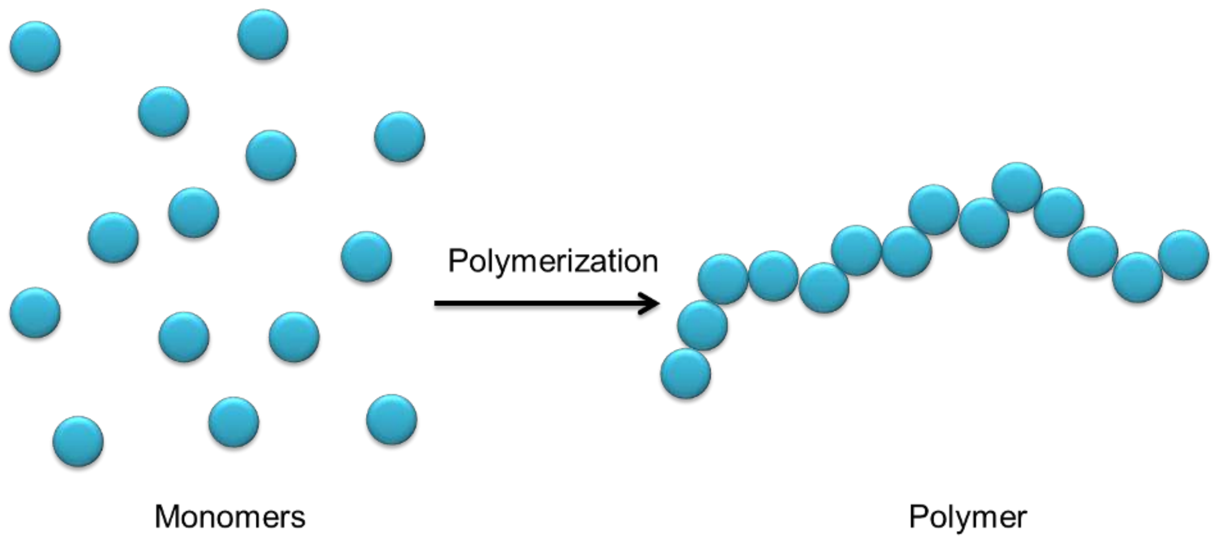
What paint can do – Part 2

Paint raw materials

How can the properties of the individual paint layers be achieved? To answer this question, let's peek into a paint can and take a closer look at the individual components.



The binder is an important and essential part of a paint formulation and is often referred to as resin. The names of the paint technologies are usually defined according to the resin. Resins hold the innermost part of the coating together. These are long-chain molecules (polymers) formed by the smaller monomeric components in a chemical reaction.



A vast array of types of resin, some of which are tailor-made, reflects the range of different requirements. The high share of resins in the paint means that their selection can be used to fine-tune paint properties. Resins are thus considered to be at the very heart of the coating formulation.

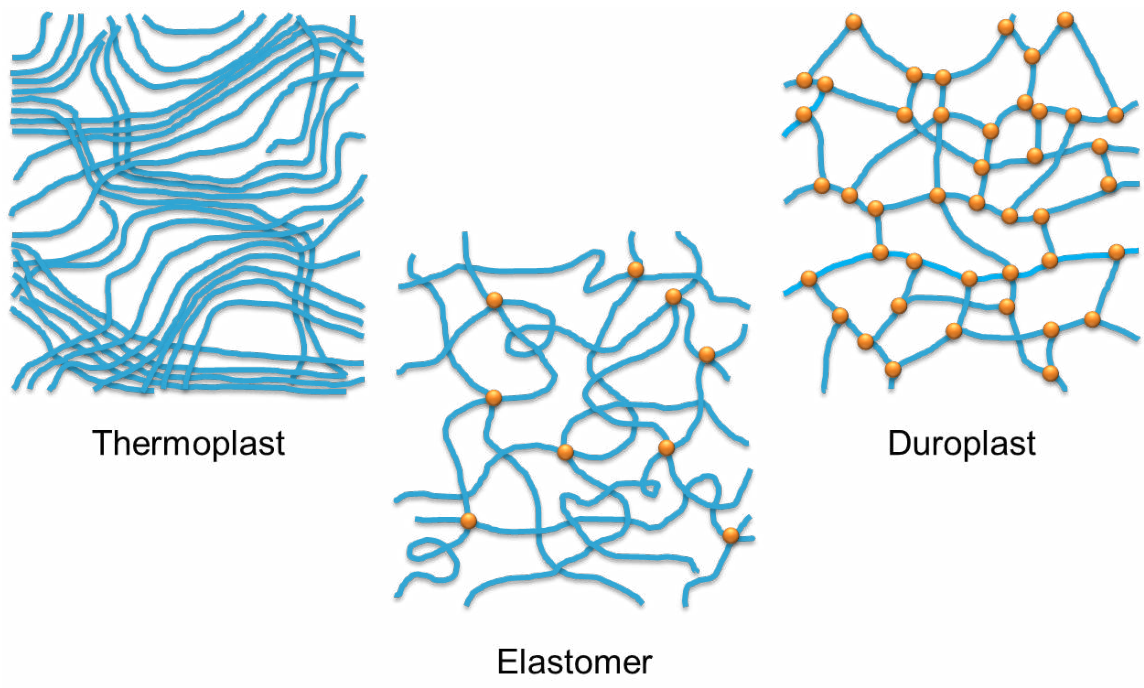
Most polymers that are used as binders in the paint initially exist as linear chains in solid or liquid form that dissolve in a solvent (but also water) and "melt" when the temperature is increased. They are referred to as thermoplasts, whose polymer chains can be shifted against each other starting from a certain temperature and in so doing make the material flow. The thermoplasts can be easily processed thanks to their solubility and their usually low viscosity and can be integrated well into the paint. Since most paints are baked after they are applied, this meltability also contributes to rendering a smooth surface.

However, these soluble chains can also make paint systems vulnerable, for instance, when they come into contact with solvents, such as those contained in cleaning agents. When this occurs, the polymer chains can dissolve again and destroy the paint film in the process. This is the case for paints that dry physically.

Thus, for long-lasting resistance, the individual strands must be connected. If they are connected at several places, an elastic material is created: an elastomer. While the chains are still flexible, they "jump" back to their original form after they are subjected to pressure.

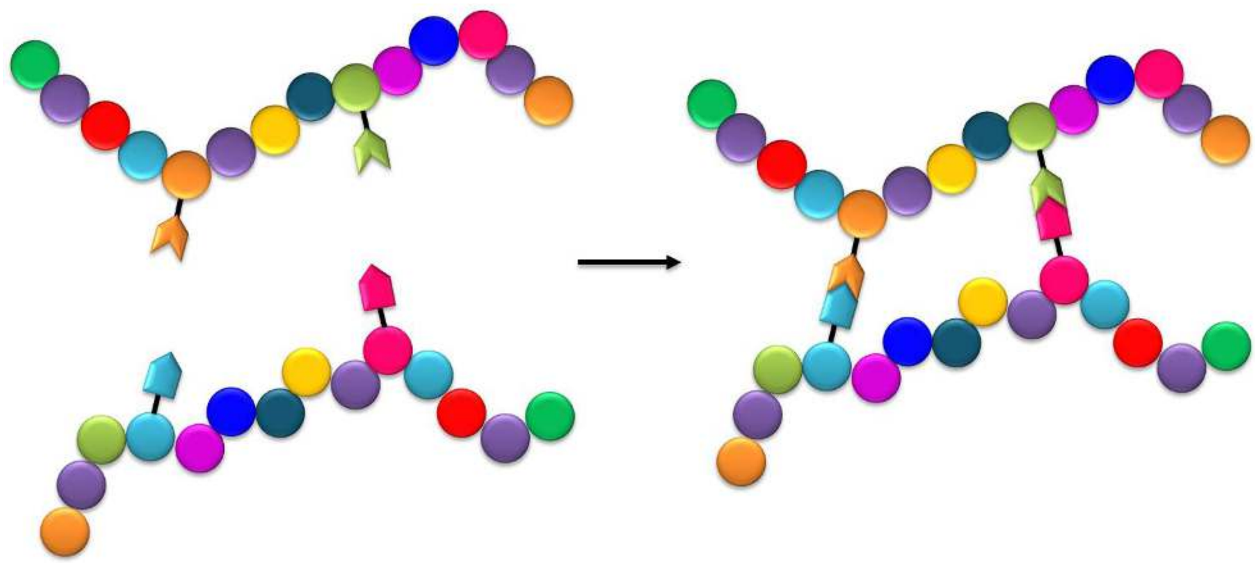
If the number of connection sites is increased to form an ever-denser network, the material becomes increasingly harder and more resistant, forming so-called duroplasts.

Such cross-linked structures are insoluble. They can only integrate solvents through sources in the network, which becomes more difficult as the degree of cross-linking increases.



To improve applicability, thermoplastic polymers are integrated into the wet paint material. However, after the application process, a network needs to form that gives the paint long-lasting resistance. This cross-linking reaction is triggered by heat during baking, but can also be launched by other stimulants such as UV radiation. In the different layers, different degrees of cross-linking are desired. For instance, the filler achieves its flexible properties by means of a rather low share of cross-linking sites. A clearcoat requires high cross-linking density in order to offer scratch and solvent resistance.

For the cross-linking structure in the paint, usually two different polymers are used whose different side groups can interact. The reactive compound is referred to as hardener. It does not always have to involve a long linear chain, however. Smaller, soluble compounds with several cross-linking sites are also used.

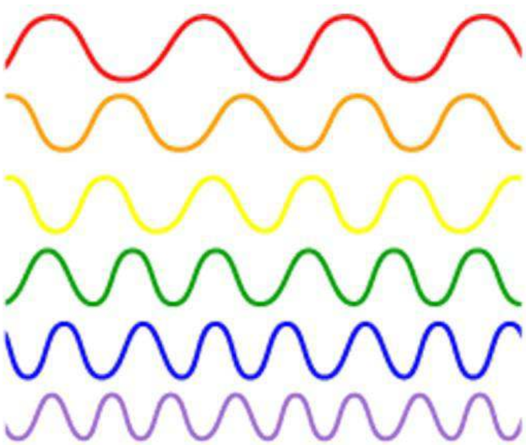


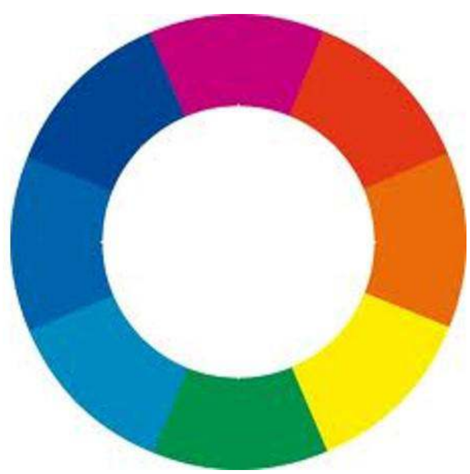
Solvents, whether they are water or organic solvents, are a special ingredient of paints because their use is only temporary. They are used to keep the paint liquid during production, first giving it a long shelf life and then making it sprayable and finally ensuring good film formation. Afterward, the solvent is no longer needed and should be removed during drying or baking. For this reason, strict attention needs to be paid regarding the temperature at which the solvent evaporates and whether it could cause damage during evaporation, such as solvent inclusions (solvent boils/popping). In many cases, it is also possible to use reactive thinners, for example, monomers or other small reactive components that initially help keep the paint liquid but after drying are firmly linked with the binders and can no longer escape.

Color paint systems such as the basecoat in the automotive sector contain pigments. These are powder-shaped colorants that are insoluble, in contrast to the dyes in the application medium.

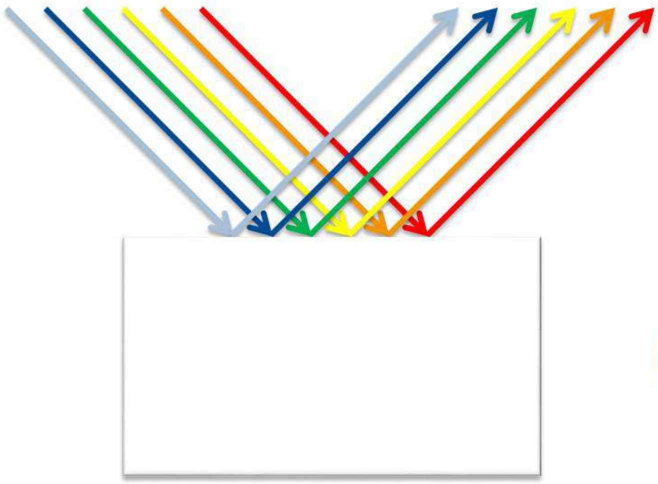
Therein lies the challenge. Pigments cannot be simply dissolved in the paint. Instead, similar to the method used for making pudding or white sauce, a paste-like mass must first be prepared that can then be blended into the paint. It is important for each pigment particle to be completely enclosed by binder. This "dispersing" can be very time-consuming, depending on the pigment. "Over-dispersing" may destroy the particles, since they are virtually ground up, which changes the properties (and the color). In addition to the desired color and effect, the selection of the pigments also allows the hiding power and additional functions such as protection from corrosion and UV light to be achieved.

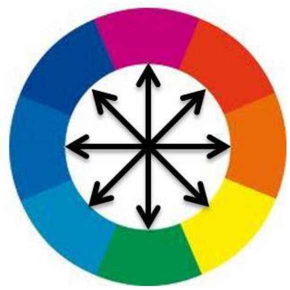
In order to understand how colors come about, let's start by looking at white sunlight. If the sunlight is refracted and broken down into its spectral colors, for instance, when there is a rainbow, you can see the different colors it is composed of. These colors correspond to different wavelengths, with red light having the longest wavelength and violet light having the shortest wavelength. Two colors each are complementary, meaning that they cancel each other out, producing white light. These colors are directly across from each other on the color wheel.



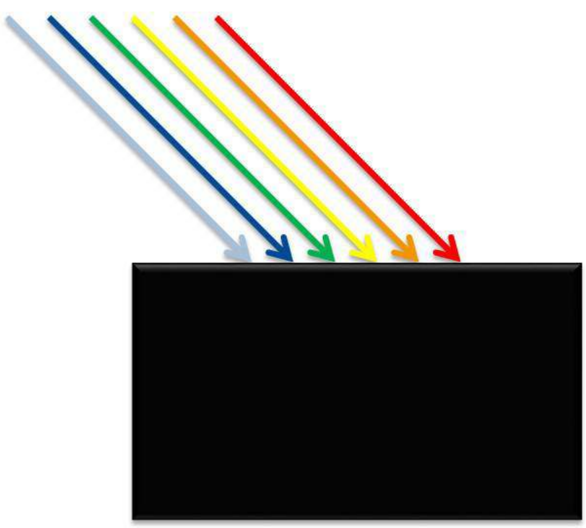


Thus, if you have a white object, all of the light's wavelength ranges will meet on it and are reflected in their entirety. They combine with their respective complementary color to produce white light and the object appears white.

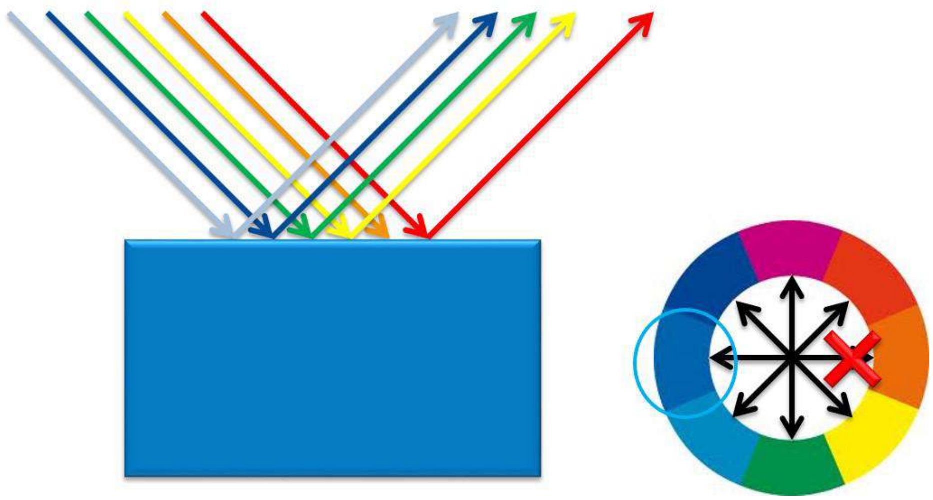




On a black object, all wavelength ranges also meet. However, the energy they provide is absorbed completely by the molecular structures of the black pigment. No light is reflected, which is why the object appears to the viewer as black.



If white sunlight encounters a blue body, all wavelength ranges are reflected, apart from that of orange light. Its specific energy is the only energy that can be absorbed by the pigment molecules. All other colors combine with their complementary color to produce white light. Only the blue light no longer has any option for combining and therefore remains as the visible color impression of the object.



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