Panel No. 5 (P5)

Damage to plastic binding

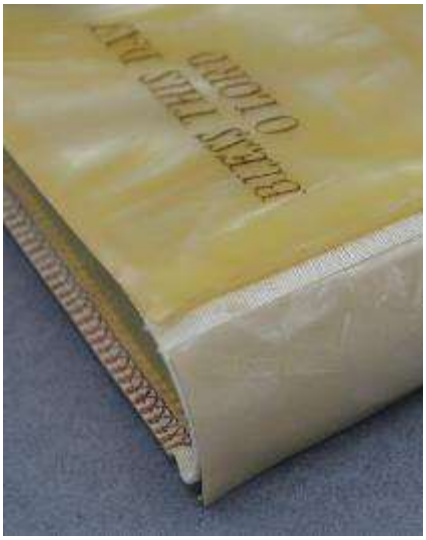
Degradation of cellulose nitrate and polyurethane book covers

The most important physical and chemical degradation factors of polymeric synthetic materials include UV radiation, moisture, oxygen, ozone, mechanical stress, exposure to various chemicals, etc. In general, biofouling is rare in synthetic polymer materials. The most common types of damage to synthetic materials include surface soiling (mostly from dust) and mechanical surface damage (grease, abrasion and scratches) caused by careless handling and improper storage prior to acceptance into the library collection. In the case of books with plastic covers, the frontispieces are peeled off or the covers are completely separated from the block; barcode labels and colouring around them are peeled off; parts of the paper covers of adjacent books are glued to the plastic covers, etc.

Deformation of boards due to collapse of the spine of the book

Cellulose nitrate

Cellulose nitrate is a durability-sensitive material that degrades relatively quickly due to light, increased humidity and heat. When it comes into contact with UV radiation, the main polymer chain splits, which causes a reduction in strength and the formation of cracks. Visually, exposure to light is manifested by yellowing.



Yellowing of cellulose nitrate plates caused by light

The main degradation product of cellulose nitrate is nitrogen dioxide, which is a corrosive gas of acidic nature that can react with air oxygen and water to form nitric acid. Acidic degradation products are hazardous both to surrounding objects (e.g. metal accessories) and to the cellulose nitrate itself as they accelerate further degradation.

Corrosion of metallic elements of book binding caused by degradation of cellulose nitrate

Another problem with cellulose nitrate is the release of the plasticizer from the book boards, which leads to shrinkage and brittleness, which can result in the book boards peeling away from the cover and cracking. The loss of the plasticizer represents the so-called first stage of degradation. The next stage is the formation and expansion of cracks and yellowing. In the last stage of degradation, the material completely disintegrates into powder.

Polyurethane

Polyurethanes (PUR) form a large group of polymers with different properties. Based on the different composition and constitution, they can be in the form of thermoplastics, reactoplastics and elastomers. In bookbinding, polyurethanes are most commonly found in the form of book coverings, called faux leather or leatherette. Apart from bookbinding, the largest use of polyurethanes is in the production of foam materials (Molitan).

According to their chemical structure, polyurethanes can be divided into two types: ester and ether. Ester types of PUR contain an ester group in the chain and are more susceptible to degradation by water, so-called hydrolysis. Ether types contain ether groups in their chains and are more resistant to hydrolysis, but are more easily oxidized in the presence of light, so-called photooxidation.

Visual signs of degradation of ester types of PUR leathers include separation from the textile backing and cracks.

Damaged and degraded polyurethane coating

During degradation, the chemical bonds are broken, which can result in the formation of adipic acid crystals. Degrading polyurethanes release nitrogen volatiles that can stimulate the corrosion of metallic accessories such as brass foils.

Brass foil corrosion due to degradation of polyurethane coating of book covers

Polyurethane foams degrade faster than films or fibres because the formation of cells/pores allows air, including oxygen and gaseous pollutants, to pass deep into the material. Due to the large surface area of the foams, oxygen reacts with the polymer to a greater extent, resulting in discoloration, sticky surface and disintegration of the foam object.