Dammar resin

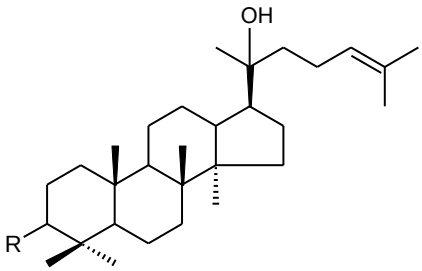
Dammar resin is a pale-yellow resin that is obtained from various species of trees belonging to the *Dipterocarpaceae* family that grow in the East Indies (particularly in Malaysia, Indonesia, Sumatra and Borneo) [1-3].

Dammar resin mainly consists of tetracyclic triterpenoids (hydroxydammarenone, aslo known as dipterocarpol, dammarenolic acid, dammaradienone, etc.). It also contains pentacyclic triterpenoids of olanane, ursane and hopane series, such as oleanonic/ursonic acid or aldehyde, oleanolic/ursolic acid or aldehyde, nor-amyrone, etc. The more common components of dammar resin are presented in Fig. 1. In addition to triterpenoids, the resin contains a small amount of sesquiterpenoids and a polymeric fraction related to the sesquiterpene cadinene ($C_{15}H_{24}$) [1-6].

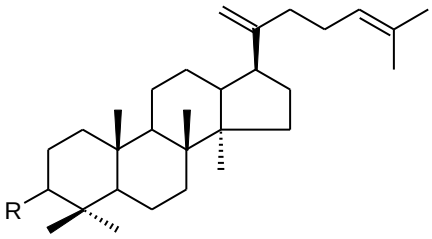
Dammar resin fully dissolves in organic solvents: turpentine, white spirit, toluene, dichloromethane, etc., but is only partially soluble in alcohols. Dammar resin has good optical and adhesive properties and is less acidic compared to other terpenoid resins, thus it is less damaging to basic pigments and linen canvas. [3, 6, 7] Due to these properties, dammar resin has been extensively used for the production of **painting varnish** since the 19th century [2, 3]. The varnish layer obtained with dammar varnish is thin, colourless, bright, and elastic. In addition to offering protection to the object, it also enhances the colour nuances by helping to make the colours brighter and more vibrant.

With time the composition of dammar resin gets more complex. Rapid oxidation that is accompanied by (partial) polymerisation and decomposition of the original compounds leads to a highly complex combination of old and new compounds. [5, 6, 8-10] These ageing processes are visible in the resin but also in the varnish coat. With time dammar varnish layer gradually yellows (although to a lesser extent than varnishes made from e.g., diterpenoid resins), becomes brittle (cracks may appear), and the solubility of it decreases. Therefore, during the restoration and conservation of artworks, stronger and more damaging solvents are needed to remove the varnish. [4, 6, 7]

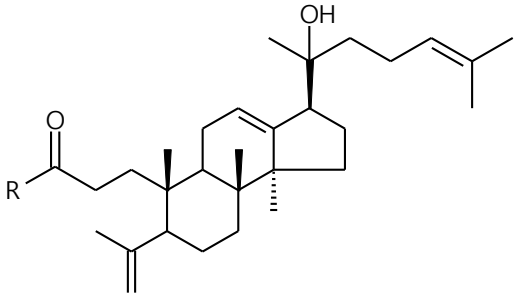
More information about the ageing of dammar resin, please see the following video: Chemistry of ageing: IV. EXAMPLE: DAMMAR RESIN



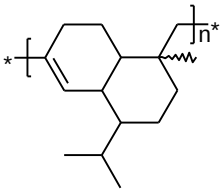
R	Compound
O	Hydroxydammarenone ($C_{30}H_{50}O_2$)
OH	Dammarenediol ($C_{30}H_{52}O_2$)



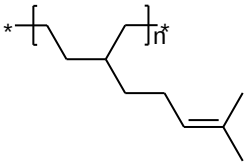
R	Compound
O	Dammaradienone ($C_{30}H_{46}O$)
OH	Dammaradienol ($C_{30}H_{50}O$)



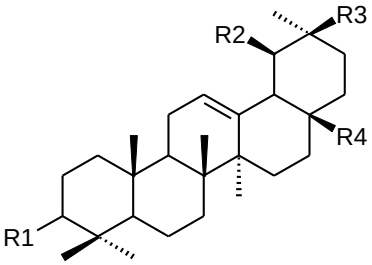
R	Compound
OH	Dammarenolic acid ($C_{30}H_{50}O_3$)
OMe	Dammarenolic acid methyl ester ($C_{31}H_{52}O_3$)



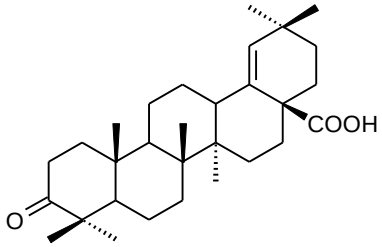
Polycadinene ($[C_{15}H_{24}]_n$)



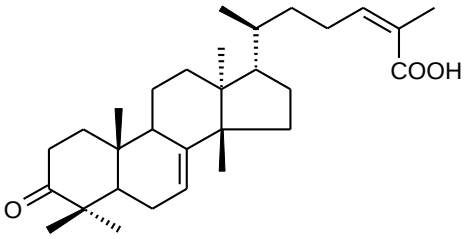
cis-1,4-poly-*β*-myrcene ($[C_{10}H_{16}]_n$)



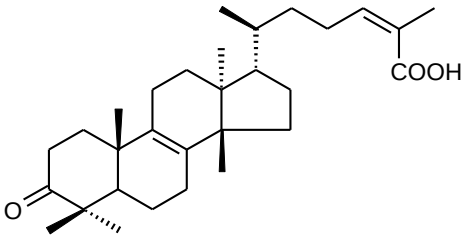
R1	R2	R3	R4	Compound
O	CH_3	H	H	Nor-*α*-amyrone ($C_{29}H_{46}O$)
O	H	CH_3	H	Nor-*β*-amyrone ($C_{29}H_{46}O$)
O	H	CH_3	CHO	Oleanonic aldehyde ($C_{30}H_{46}O_2$)
O	CH_3	H	CHO	Ursonic aldehyde ($C_{30}H_{46}O_2$)
O	H	CH_3	COOH	Oleanonic acid ($C_{30}H_{46}O_3$)
O	CH_3	H	COOH	Ursonic acid ($C_{30}H_{46}O_3$)
OH	H	CH_3	CHO	Oleanolic aldehyde ($C_{30}H_{48}O_2$)
OH	CH_3	H	CHO	Ursolic aldehyde ($C_{30}H_{48}O_2$)
OH	H	CH_3	COOH	Oleanolic acid ($C_{30}H_{48}O_3$)
OH	CH_3	H	COOH	Ursolic acid ($C_{30}H_{48}O_3$)



Moronic acid ($C_{30}H_{46}O_3$)



Masticadienonic acid ($C_{30}H_{46}O_3$)



Isomasticadienonic acid ($C_{30}H_{46}O_3$)

Fig. 1. Selection of components present in dammar and mastic resins. Components present in, both, dammar and mastic resins are highlighted with green background [6].

Mastic resin

Mastic resin is collected from shrubs of the *Pistacia* genus (*Anacardiaceae* family) that grow in the Mediterranean area, mainly from the pistachio tree *Pistacia lentiscus* [1]. Since the Middle Ages, mastic resin has been exclusively produced on the island of Chios (Greece) [2].

Mastic resin has been in use since ancient times. The remnants of the resin have been found at different sites in the Mediterranean area and they date back to the establishment of the first permanent settlements in this area (5500-5000 BC) [2]. The selection of applications that mastic resin has been (and still is) used is broad: adhesive for wounds, filler for tooth cavities, relief for toothache, flavouring component in alcoholic beverages, etc. The name of the resin refers to the Greek word for chew, and the resin is used for masticatory purposes even nowadays [2].

The chemical composition of mastic resins is very complex and even more diverse compared to dammar resin. The resin consists mainly of triterpenoids: masticadienonic acid, isomasticadienonic acid and moronic acid, and lupeol. It shares a number of compounds with dammar resin, such as hydroxydammarenone, oleanonic acid, oleanonic aldehyde, nor-amyrone, etc. (see Fig. 1). [1, 2, 4, 6, 10, 11] However, mastic resin is lacking ursane-type compounds (compared to dammar resin) [4, 12]. The resin also contains a fraction of monoterpenes, e.g., α-pinene, β-pinene, limonene, β-myrcene, etc. [2]. The polymeric fraction of mastic resin has been identified as polymerised cis-1,4-poly-β-myrcene ($C_{10}H_{16}$). [1, 3, 4, 6, 13]

Mastic resin dissolves in turpentine and aromatic solvents, such as toluene, benzene, etc. It is only partially soluble in alcohols (similarly to dammar resin, the polymeric fraction of mastic resin is not soluble in alcohols). The resin is used for the production of oil-, spirit- and watercolour varnish that has been used since the Middle Ages. The properties of mastic varnish are similar to dammar picture varnish: it leaves a clear and elastic film that offers protection to the object and helps to highlight and brighten the colours [2, 6]. At the same time, the layer of mastic varnish yellows more and thereby becomes more brittle than dammar varnish.

The composition of mastic resin and varnish becomes more diverse with time. The original compounds undergo oxidation, polymerisation and also some degradation may occur. This leads to changes in the properties of the resin and the varnish: the solubility of the material decreases, it becomes yellow and more brittle [6, 10].

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