Supporting high-performance stereolithography through compatibility with various LED light sources and maintaining the original transparency of the resin

SANYO PRODUCT TOPICS

Stereolithography enables the rapid and precise creation of smooth-surfaced objects, leading to its widespread application across various industries, and the photo-curable resins utilized in this technology are also required higher performance.
We would like to introduce San-Apro's photo-cationic polymerization initiator that supports this high performance.

Stereolithography used in 3D printers

One method for producing 3D models using a 3D printer is stereolithography, which solidifies models by irradiating light.
Stereolithography is a method in which liquid photocurable resin solidifies layer by layer upon light irradiation, building up a three-dimensional object. Based on 3D CAD data, a highly accurate 3D plastic model is produced by controlling the irradiating laser beams or other light sources.
Stereolithography has many advantages, such as fast printing speed, smooth surface, transparent features, and the ability to produce objects ranging from small to large. However, it requires some care and additional work such as material storage and post-processing after modeling, so it has been mainly used for industrial applications.
It is currently used for prototyping various products, including electronic devices and parts for automobiles and aircraft. It is also used to make models that serve as the basis for molds and for the production of medical components, which are often made in small batches or to order, and research is also underway into the production of minute micro-level models.

Photo-cationic polymerization initiator that generates acid in response to light

The materials used in stereolithography are photocurable resins that undergo polymerization reactions upon exposure to light, causing the substance to solidify. There are two main types of resins: acrylic resins that polymerize with radicals and epoxy resins that polymerize with cations (acids).
In general, acrylic-based resins exhibit a fast curing speed but possess a brittle nature, whereas epoxy-based resins have a slower curing speed but feature high strength. In a familiar way, it is like the difference between instant adhesives and epoxy adhesives used for DIY.
Each photocurable resin contains a photopolymerization initiator that decomposes by absorbing light and generates the radicals and acids necessary for polymerization. Particularly in the case of epoxy-based resins, those that generate the acid necessary for cationic polymerization of epoxy systems are called photo cationic polymerization initiators (photoacid generators).

"VC - 1" and "ES - 1" compatible with LED light sources

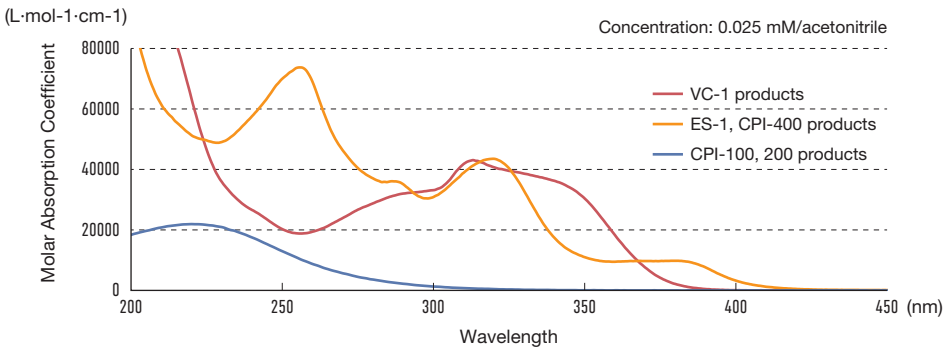
Photo-cationic polymerization initiators are required to have curing properties that allow resins to harden quickly. Curing ability improves with the higher quantity and stronger intensity of generated acid, so it is necessary to design the structure to absorb light at the irradiated wavelength as much as possible, and generates as much strong acid as possible.
In the past, laser light sources in the high-energy ultraviolet region with a wavelength of around 355 nm were commonly used for photopolymerization. However, in recent years, energy-efficient LEDs with wavelengths in the visible light range, such as 395 nm and 405 nm, are now used for this purpose.
San-Apro has previously introduced the CPI-400 products, designed to accommodate these wavelengths. The newly developed VC-1 and ES-1 products represent further advancements in performance compared to the existing CPI-400 products.
The CPI-400 products is a non-antimony-based photoinitiator for cationic polymerization with excellent curing properties. However, it absorbs a small amount of light in the visible light range above 400 nm, giving the resulting resin a slight yellow tint rather than being completely colorless. While this characteristic is acceptable in applications where color is not a concern, it poses limitations in optical uses where transparency is required. VC-1 increases absorption in the ultraviolet region and decreases absorption in the visible light region (over 400 nm), thereby minimizing coloring derived from photo-cationic polymerization initiators, and improving the transparency of resins in particular.
On the other hand, ES-1 has the same amount of light absorption in each wavelength region as the conventional CPI-400 products, but by increasing photolysis efficiency, it is designed to generate more acid with the same amount of light absorption, resulting in excellent curability.
Additionally, non-antimony-based products have traditionally had low solubility, but ES-1's high solubility makes it possible to incorporate it into a variety of systems. Both products are already

available in small quantities, and preparations for large-scale production are underway.

Contributing to Society with a Diverse Product Lineup and Innovative Technological Development

Since around 2000, San-Apro has developed various photoinitiators for photo-cationic polymerization in response to the advancements of stereolithography technology. As a result, we have established a comprehensive product lineup capable of accommodating a wide range of light wavelengths. This allows us to offer products tailored to diverse applications and usage methods in stereolithography applications.
The developed VC-1 and ES-1 products can cure efficiently even with energy-efficient LEDs, contributing to a reduction in power consumption during stereolithography. Since energy conservation leads to a reduction in CO_2 emissions, this technology can contribute to SDGs Goal 13, " Climate Action ". In addition, the evolution of photo-cationic polymerization initiators will naturally lead to the widespread use of 3D printers, thus contributing to Goal 9 " Industry, Innovation and Infrastructure " in terms of promoting technological innovation.
Currently, our product lineup mainly covers light from ultraviolet to visible light, but we are also developing products that can accommodate wavelengths such as near-infrared. Photo-cationic polymerization initiators are also used as photoacid generators in the field of semiconductor manufacturing, and further expansion of their application fields is expected.
San-Apro will continue to contribute to society with its various product lineup and new technological developments.

■Ultraviolet-Visible Absorption Spectroscopy Chart of VC-1 and ES-1



■San-Apro's VC-1 and ES-1 products

Product series	Product name	Compatible wavelength (nm)			Appearance	Anion (Generated acid)	Features
		365 (i line)	405 (h line)	436 (g line)			
VC-1	VC-1FG	Excellent			White to pale yellow powder	Special anion	Combines improved i-line sensitivity with transparency in the visible light range. It suppresses initiator-derived coloration of resins and, when combined with special anions, also excels in suppressing coloration during heat curing.
ES-1	ES-1B	Excellent	Excellent	Good	Pale yellow to yellow powder	$B(C_6F_5)_4^-$	i~g-line highly sensitive, non-Sb (antimony) type borate anionic initiator (various other anions are also available).
(Comparison) CPI-100	CPI-101A	Good			Colorless clear solution	SbF_6^-	General-purpose grade

Please contact San-Apro sales representative when handling these products. (Tokyo: +81-3-3500-3492)
Also be sure to read the “Safety Data Sheet” (SDS) in advance. It is the responsibility of the user to determine the suitability and safety in the intended use.