積層板とは何か？

積層板とは強化材としてのガラスクロス、綿布、紙などの基材に、調整された樹脂ワニスを含浸させ、乾燥処理した半硬化状態のシート「プリプレグ」をステンレス板の間に複数枚積み重ね、加熱プレスすることにより完全硬化させた板です。軽量高強度で、耐薬品性、電気的特性などに優れています。構成する基材と樹脂の組み合わせが、製品の特性を左右します。電気絶縁材料として、また機械分野の構造材料として、さらに断熱材料にとさまざまな用途があります。ニコライト®積層板は日光化成創業時からの、まさに原点ともいえる製品で、産業界において長年の実績があり、絶え間ない研究により新製品も続々誕生しています。

Laminated sheets are made from base materials such as glass fiber, cotton, and paper which have a strengthening effect. The materials are impregnated in an adjusted resin varnish and are dry treated. Several of these half-hardened sheets, called 'pre-peg' are stacked and sandwiched between stainless steel sheets. Then, they are placed in a heating press to become the finished product — completely hardened sheets. The lightweight but strong sheets excel in chemical resistance, electrical properties and more. The composition of the base material and its combination with resin controls the performance of the product. The uses for laminated sheets are vast. They serve as base material for electrical insulators, structural materials for machines, and heat insulators. The NIKOLYTE® laminated sheet is the original creation of NIKKO KASEI, which has a long business history. The company consistently conducts research to develop new products.

1.積層板と基材 The Laminated Sheet and Base Material

一般的な積層板の基材には、紙、綿、ガラス繊維、カーボン繊維が使われます。繊維基材は、織物状、マット状などの形態で供給されます。表面処理、織り方などで多種多様な品種があります。連続生産するために、基材はロール状の形態でなければなりません。業界では紙を基材とした積層板が多いのですが、日光化成は綿織物、ガラスクロス、チョップドストランドマットを基材とした製品を中心に製造しています。その他カーボンクロス、カーボン不織布、テトロンクロス、等の特殊な織物もあり、要求特性に応じて目的に合った基材を使い分けています。

The base materials for the general laminated sheet are paper, cotton, glass fiber, and carbon fiber. The fiber material is supplied in the form of fabric, mat, etc. The various types of surface treatment and weaving methods create many different products. To enable continual production, the base material must be produced in rolls. While many companies produce laminated sheets using paper as the base material, NIKKO KASEI is unique in that it focuses on using cotton fiber, glass fiber cloth, and chopped strand mats as base materials. In addition, we offer laminated sheets made with special fabric such as carbon cloth, non-woven carbon fabric, and tetron cloth, which are chosen to precisely match properties needs and purposes.

2.積層板と樹脂 The Laminated Sheet and Resin

積層板の原料としては、主に熱硬化性樹脂が使われます。なかでもフェノール樹脂とエポキシ樹脂は、電気絶縁材料や機械用構造材料として圧倒的な市場を占めています。産業界の多様な要求特性に応えるため、日光化成では不飽和ポリエステル樹脂、メラミン樹脂、シリコーン樹脂、ポリイミド樹脂、無機質系樹脂を原料とした積層板も製造しています。
製造過程で樹脂の組成を変えたり、他の副原料を組み合わせることで、優れた電気特性、難燃性や耐熱性及び加工性を付加することが可能です。

The main ingredient of the laminated sheet is thermosetting resin. Among such resins, phenolic resin and epoxy resin sheets dominate the market for electrical insulators and structural materials for machines. NIKKO KASEI also manufactures laminated sheets using unsaturated polyester resin, melamine resin, silicone resin, polymide resin, and inorganic resin, to meet the various properties demands in the industrial field. By changing the mixture of the resin in the manufacturing process, or by combining it with a second material, we are able to increase electrical properties, flame resistance, heat resistance, and processing properties.

絶縁材料の熱区分 (IEC.Pub.85) Thermal Evaluation and Classification of Electrical Insulation

耐熱クラス Thermal class	Y	A	E	B	F	H	200	220	250	≧250
許容最高温度 (℃) Allowable maximum temperature	90	105	120	130	155	180	200	220	250	25℃間隔で区分 Classify at 25 ℃ interval

NIKOLYTE

3.積層板の製造方法 The Laminated Sheet Manufacturing Method

積層板の製造方法には、大きく分けて3工程あります。まずプリプレグを製造する含浸乾燥工程、次にそのシートを複数枚積み重ねて熱硬化させるプレス工程、最後に一定寸法に切断する仕上工程を経て積層板になります。

The laminated sheets manufacturing method can be divided into three processes. First, the impregnated drying process creates the pre-peg, then the press process stacks several sheets for thermosetting, and last the final finishing process cuts the sheets into uniform sizes to be laminated sheets.

(1) 含浸乾燥工程 Impregnated Drying Process

濃度調節したワニス(液状化した樹脂)を基材に含浸させ、乾燥炉を通します。乾燥炉を通してワニスの溶剤を蒸発させると同時に樹脂の硬化を進めて半硬化状態とし、いわゆるプリプレグを作ります(常温では相互に粘着しない程度まで乾燥)。次にそのプリプレグを一定寸法に裁断します。乾燥炉には、縦型と横型とがあり、横型はスペースを取りますが高速処理が可能となります。乾燥の熱源としては、蒸気を熱源として熱風を循環させる方法と熱媒を循環させる輻射方式とがあります。(図1)

The product is impregnated in a concentrated varnish (liquid form of resin) and is placed in a dryer. Simultaneously, the varnish solvent is evaporated and the hardness of the resin is enhanced to a half-finished state. This is called the pre-peg (dried to a point where the pre-pegs do not adhere to one another at room temperature). Next, the pre-peg is cut into uniform sizes. There are two types of dryers: the vertical and horizontal. The horizontal dryer occupies more space but is able to dry in a shorter time. There are two drying methods: a method which circulates hot air from steam and a radiation method which circulates thermal-liquid (see the figure 1).

(2) プレス(積層成形)工程 Press (Molding) Process

適当な枚数のプリプレグを積み重ね、鏡面板(一般的にはステンレス製)の間にはさみ、図2に示したような多段式プレスに挿入します。積層プレスの熱盤の間に多数枚挿入し、その上下には圧力分布を均一化するためクッション材を置きます。樹脂が完全硬化するまで加熱・加圧を同時に行います。プリプレグ特性に合わせたプレスの温度・圧力スケジュールの設定が重要です。加熱終了後、加圧状態で室温まで冷却します。プレスでの加熱・冷却とも熱盤からの伝導が主で、仕込まれた積層板は内側の層ほど伝熱の遅れが生じるため、この差を考慮した条件とする必要があります。プレスを降下した後、鏡面板の間から積層板を取り出します。プレス機熱盤の熱源としては、含浸乾燥機同様にスチームが一般的ですが、熱したオイルを使用することもあります。

An appropriate number of pre-peg sheets are stacked and sandwiched between mirror-surfaced (stainless steel) sheets and placed in a multi-platen press, as shown in the figure 2. Several sheets are placed on the heating base of the laminated press. On top and underneath the sheets, a cushioning material is added to equalize the distribution of pressure. Heat and pressure are applied simultaneously until the resin is thoroughly hardened. It is important to arrange a heating and pressure schedule that is appropriate for the desired pre-peg performance. After the heating process is complete, the sheets are cooled to room temperature without releasing the pressure. Thermal conductivity comes mainly from the heating base for both heating and cooling. It is important to note that thermal conductivity is slowed by the need to pass through the layers of sheets enroute to the center. After the laminated sheets are taken out of the press, they are removed from the mirrored sheets. Like the impregnated dryer, heat for the press base generally comes from steam. However, heated oil is also used.

(3) 仕上工程

仕上工程は、プレス終了後取り出した積層板の周辺に流れ出た樹脂をトリミングして定尺に切断する工程です。樹脂・基材の種類によりますが、加工工具には超硬やダイヤモンドが使われます。

In the finishing process, the laminated sheets are removed and excess resin is trimmed off. Although it depends on the type of resin and base material, the processing tools used for trimming are made of hard metal tool or diamond tool.

図1.塗布乾燥機
fig1. Drier

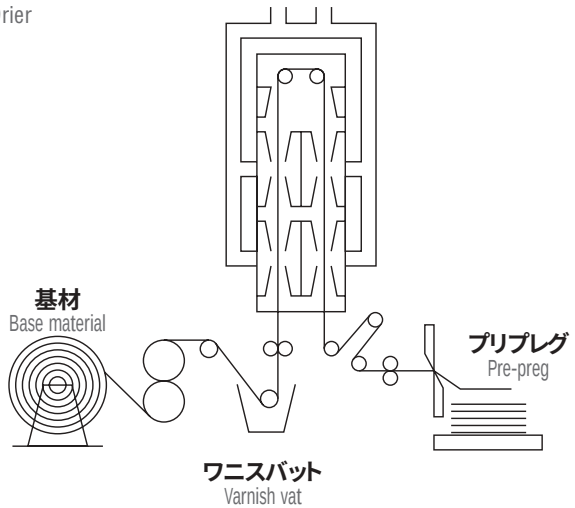

図2.多段式プレス
fig2. Multi-platen press