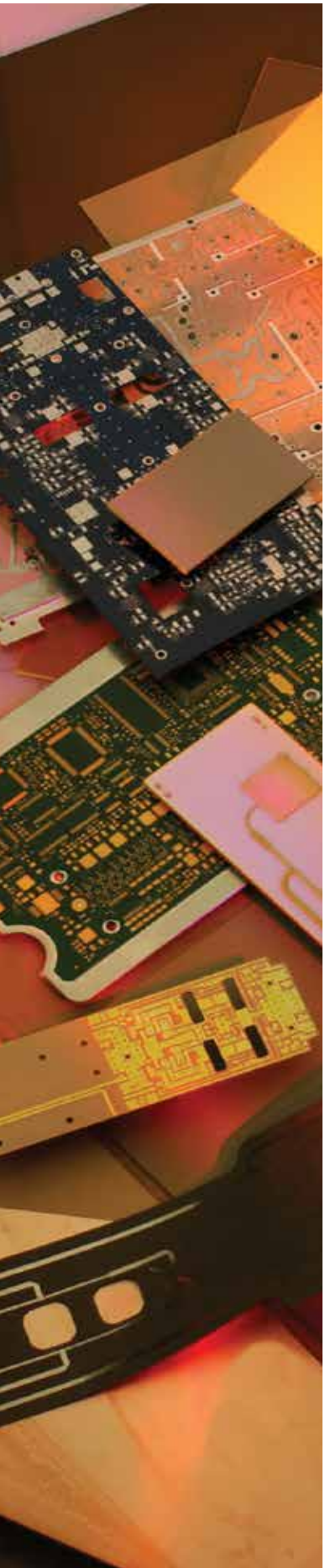
Low-Flow Guide

ARLON ELECTRONIC MATERIALS



Low-Flow prepreg, also referred to in some cases as “No-Flow” prepreg, is engineered to have a controlled melt viscosity that results in controlled low flow for laminating rigid flex products or bonding heat sinks to printed wiring boards. Characterized by a high melt viscosity, Low-Flow prepregs do not flow excessively into cutouts in heat sinks or past the edge of the rigid segment of a rigid-flex board, so that insertion of devices into cutouts is enabled, and flexibility of the flex section of the board is maintained.

Arlon manufactures a range of Low-Flow prepregs designed for a variety of heat sink and rigid-flex bonding applications. Individual product lines may also have some variation in available glass styles and flow ranges to further provide optimized materials for specific applications.

47N Modified Epoxy Low-Flow (Tg=135°C) – 47N is optimized for bonding PWB’s to heat sinks and can be processed at reduced laminating temperatures and pressures to protect devices already mounted on partially stuffed assembled devices. 47N is available in 106 and 1080 glass reinforcement styles.

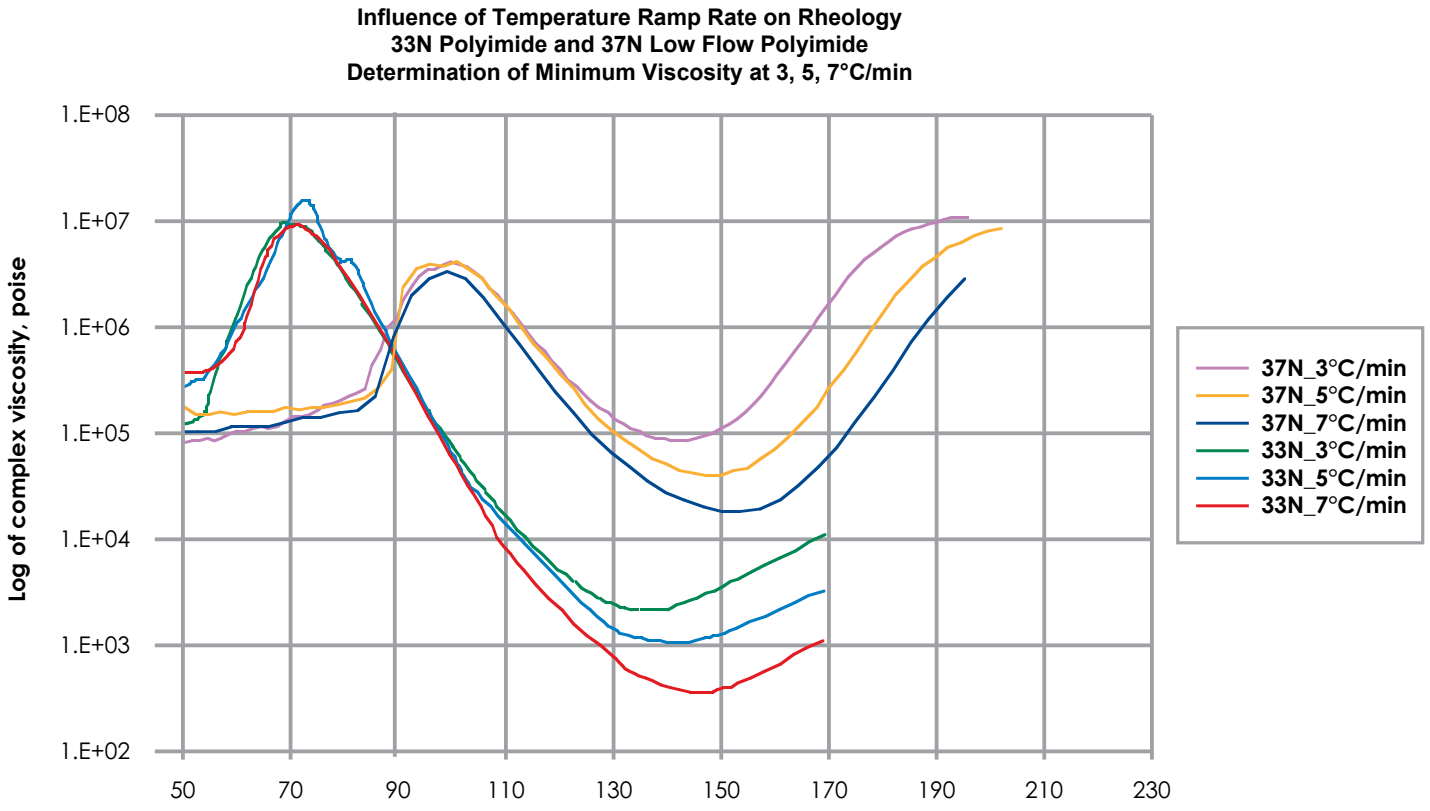
49N Multifunctional Epoxy Low-Flow (Tg=170°C) – 49N is designed primarily for use in epoxy rigid-flex assemblies, and is available in both 106 and 1080 glass reinforcement styles with flow ranges to accommodate a range of process requirements.

51N Lead-Free Multifunctional Low-Flow (Tg=170°C) – 51N is the first of a new generation of low flow products designed with enhanced melt rheology for better bond and wetting and using a resin system specifically engineered for lead-free application environments.

37N Epoxy Modified Polyimide Low-Flow (Tg=200°C) – 37N is Arlon’s basic polyimide Low-Flow product. Modified with epoxy for flow control and enhanced adhesion, 37N was originally designed for use in polyimide rigid-flex assemblies. 37N is available in 106 and 1080 glass reinforcements with several flow ranges.

38N 2nd Generation Modified Polyimide Low-Flow (Tg=200°C) – Designed with a significantly improved bond to untreated polyimide film, 38N was designed to offer robust rheological characteristics for a variety of rigid-flex designs utilizing adhesiveless flex products. 38N drops easily into a wide range of process conditions.

Defining Characteristics of Low-Flow Systems: Effect of Heatup Rate on Flow Characteristics



Most resin systems will respond to a change in heatup rate to provide different melt viscosities and flows. This can be seen in the above chart comparing Arlon's 37N low-flow product with Arlon's 33N standard polyimide prepreg at varying heat-up rates of 3, 5, and 7°C/minute. The following illustrates the key differences resulting from changing heatup rate, comparing a low-flow product and a standard prepreg:

Heatup Rate	Min Viscosity (poise)	Temp at Min Viscosity	Time to Min Viscosity
37N 3°C/minute	90,000	140°C	45 minutes
37N 5°C/minute	30,000	150°C	30 minutes
37N 7°C/minute	17,000	160°C	23 minutes
33N 3°C/minute	2,000	135°C	45 minutes
33N 5°C/minute	1,000	140°C	28 minutes
33N 7°C/minute	600	145°C	21 minutes

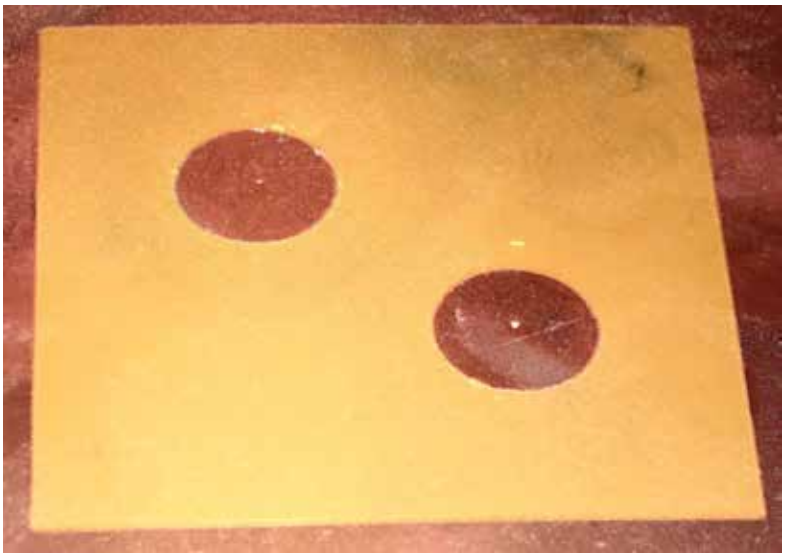
The most significant difference is the almost two orders of magnitude higher viscosity (less flow) for the Low-Flow 37N than for the standard flow 33N polyimide. This is achieved by the use of high molecular weight additives that inhibit flow, as well as careful control of the resin system advancement during B-staging. This allows for tailored flow control in applications requiring low controlled resin flow as distinct from conventional prepreg which is optimized for flowing around

etched lines and filling via holes in inner layers. Like standard flow materials, the melt viscosity of Low-Flow products can be varied by the adjustment of heat-up rate. The combination of heating rate and pressure will permit “fine tuning” of the Low Flow systems. Multiple flow ranges are available for certain products to help with process optimization.

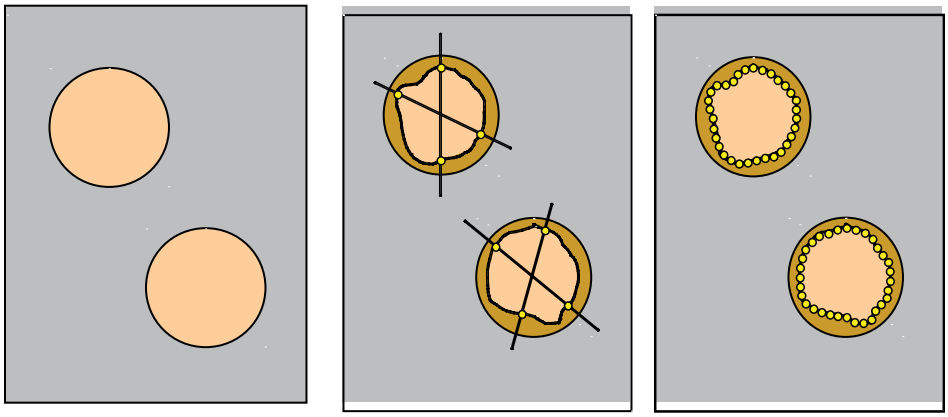
Low-Flow Characterization

Low-Flow prepregs are outside the range which can be accurately measured by the standard IPC TM-650 4” x 4” flow test and require a special test method to measure and control flow. Because the amount of flow into cutout areas is critical, the standard test consists of a sample stack of prepreg with two 1” diameter holes punched in it, which is then laminated under specified test conditions. The amount of flow into the holes is measured as the number of mils (thousandths of an inch) by which the diameter of the circle is reduced by the resin flowing into the circle. To ensure accuracy in testing, Arlon uses an advanced optical comparator to make precise and repeatable measurements of Low-Flow materials (see Figure 1, right).

The resin flows into the circle during lamination and the final diameter of the circle is measured (see Figure 2 and 3). The difference between the original 1.000” diameter of the circle and the final diameter is the amount of flow in mils. By this method (IPC TM650 2.3.17.2), a typical Low-Flow material may have anywhere between 0.030” and 0.120” of flow, depending on the grade and the degree to which the flow is restricted in the resin formula and treating (prepregging) operation.



Flow is expressed as the average amount of reduction in the diameter of the two 1” diameter holes after pressing. The diagram below shows the process. The diameter of the holes is fixed by the diameter of the punch size at a nominal 1.000”. After pressing the average flow is measured either using a caliper (Standard Measurement) or using the Arlon computerized optical measurement which calculates the mathmatical best fit for of over 500 points around the circle. The difference between the original diameter (1.000”) and the calculated final diameter is the flow in mils.



Key Properties of Low-Flow Products

Selecting the right Low-Flow product for an application, of course, requires evaluation of several key properties as they relate to the specific products being manufactured, as well as the details of the manufacturing process. Arlon offers the widest range of materials to accommodate the most complex PCB manufacturing and assembly. The following table lists key properties of Arlon Low-Flow products.

General Properties of Arlon Low-Flow Products

Property	47N	49N	51N	37N	38N
Glass Transition Temperature (Tg)	135	170	170	200	200
Peel Strength (1 oz Cu)	9 lb/in.	9 lb/in.	6.7 lb/in.	6.8 lb/in.	8.5 lb/in.
Peel Strength to Polyimide film	N/A	N/A	N/A	4.2 lb/in.	5.9 lb/in.
Thermal Conductivity (W/m-k)	0.25	0.25	0.25	0.30	0.30
Lap Shear to Aluminim (psi)	N/A	N/A	N/A	N/A	N/A
Flammability (UL-94) Water	V0	V0	V0	V0	V0
Absorption (24 hr) % (plied to 0.060")	0.1 %	0.1 %	0.1 %	< 1 %	< 1 %
CTE (X,Y) (ppm/°C)	16	16	15	17	17
CTE (Z) (ppn/°C) below Tg	85	85	44	76	54
Electrical Strength (V/mil) typ.	>1000	>1000	>1000	1,330	1600.0
Dielectric Constant @ 1 MHz	4.2 - 4.4	4.2 - 4.4	4.1 - 4.2	4.0 - 4.3	4.0 - 4.3
Dielectric Loss @ 1 MHz	0.020	0.022	0.020	0.018	0.010
Density (g/cc)	1.7	1.7	1.7	1.6	1.6

Selecting the Right Arlon Low-Flow Product for Your Application:

If the application is Rigid-Flex bonding:

- High Performance Polyimide Rigid-Flex (Adhesiveless Flex) — use 38N
  - For 2.0 mils/ply, use Style 106
  - For 3.0 mils/ply, use Style 1080
- Commercial Polyimide Rigid-Flex (Acrylic Adhesive Flex) — use 37N or 38N
  - For 1.8 to 2.0 mils/ply use Style 106
  - For 3.0 mils/ply use Style 1080
  - For general use, use 70-100 mils flow (37N), 70-120 mils flow (38N)
  - To fill heavier copper, or for additional flow, use the 100-130 mils or the 4-8% flow version of 37N

  Note: 38N was engineered to have improved bond to untreated polyimide film, so if this is critical to your process or to the end-device performance or reliability, 38N may be the better choice.
- Commercial Epoxy Rigid-Flex (Adhesiveless Flex) — use 49N or 51N (Lead-Free Applications)
  - For 2.3 mils/ply use Style 106 Glass
  - For 3.4 mils/ply, use Style 1080 glass
  - For general purpose, including heavy copper fill, use 60-120 mil flow range

  Note: 51N was engineered to have improved bond to untreated polyimide film. 51N is flow modified for lower nominal melt viscosity for enhanced wet-out and bond.
- Low Cost Commercial Epoxy Rigid-Flex (Acrylic Adhesive Flex) — use 47N, 49N or 51N
  - For 2.3 mils/ply use Style 106 Glass
  - For 3.4 mils/ply, use Style 1080 glass
  - For Tg 135°C use 47N, for Tg 170°C use 49N or 51N
  - For general purposes, use 50-100 mil flow range (60-120 for 51N and 49N)

  Note: Some low cost flex-rigid applications may be fabricated using polyester film or other lower temperature materials in place of polyimide film. In such cases the lowest temperature curing Low-Flow material is 47N which can be laminated as low as 300°F and 100 psi (depending on the amount of flow required, pressure can be adjusted)

Continued:
Selecting the Right Arlon Low-Flow Product

If the application is Heat-Sink bonding:

- Applications requiring Polyimide Tg (200°C) use 38N
  - For 2.0 mils/ply use Style 106
  - For 3.0 mils/ply use Style 1080
- Applications requiring Tg, of 130°-170°C, use 49N
  - For 2.3 mils/ply use Style 106
  - For 3.4 mils/ply, use Style 1080
  - For general purposes, use 60-120mil flow range
  - Where less flow is needed, use 30-90 mil flow range (as with critical cut-outs)
- Applications requiring low temperature and low pressure bonding (because the boards already have been assembled with some active devices) — use 47N which can be cured at reduced temperature and pressure of 300°F and 100 psi.
  - For 2.3 mils/ply use Style 106
  - For 3.4 mils/ply, use Style 1080
  - For general purposes, use 50-100 mil flow range
  - Where less flow is needed, use 30-90 mil flow range (as with critical cut-outs)
- Applications requiring the lowest cost option, where high Tg is not essential — use 47N
  - For 2.3 mils/ply, use Style 106
  - For 3.4 mils/ply, use Style 1080
  - For general purposes, use 50-100 mil flow range
  - Where less flow is needed, use 30-90 mil flow range (as with critical cut-outs)
- Applications where Lead-Free performance is indicated — use 51N

Note: Specific grades of each material have been developed in response to customer's varying processes and requirements. In general the lower flow values are recommended for heat sink bonding applications.

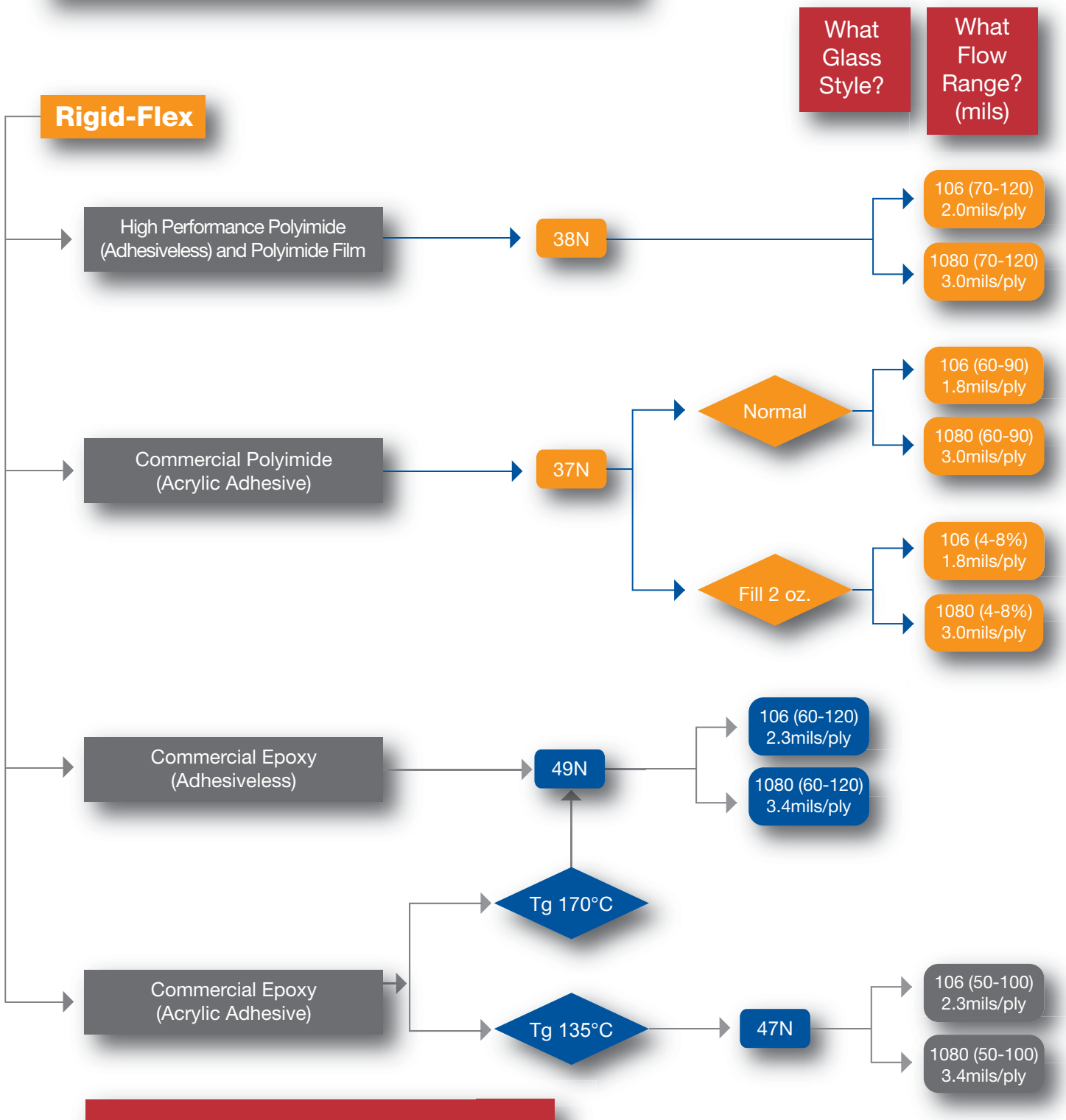
If your application is unique or not covered above, contact an Arlon technical service engineer for specific recommendations. It is likely that one of the product grades already available will be adaptable to your application. For high volume special applications, Arlon engineers may be able to develop a grade customized for your product and process.

Arlon Low-Flow Part Number List

A detailed list of the various Arlon Low-Flow grades is included below. This table shows Tg, glass reinforcement style, resin content (%), nominal pressed thickness, flow range (diameter reduction expressed in mils as noted above) and “typical application” (either R/F — Rigid Flex — or HS —Heat Sink Bonding). It also includes the Arlon part number for ease of ordering, and the most recent IPC 4101 Slash Sheet to which the product conforms.

Product	Arlon Part Number	IPC 4101/	Glass Style	Resin (%)	Tg (°C)	Flow Range (mils)	IPC TM650 Method	Typical Pressed Thickness (mils)	Typical Application
47N	47N0672	21	106	72	135	30-90	2.3.17.2A	2.3	HS
47N	47N067201	21	106	72	135	50-100	2.3.17.2A	2.3	R/F, HS
47N	47N8065	21	1080	65	135	30-90	2.3.17.2A	3.4	HS
47N	47N806501	21	1080	65	135	50-100	2.3.17.2A	3.4	R/F, HS
49N	49N067201	26	106	72	170	30-90	2.3.17.2A	2.3	HS
49N	49N067202	26	106	72	170	60-120	2.3.17.2A	2.3	R/F, HS
49N	49N806501	26	1080	65	170	30-90	2.3.17.2A	3.4	HS
49N	49N806502	26	1080	65	170	60-120	2.3.17.2A	3.4	R/F, HS
49N	49N806504	26	1080	65	170	130-190	2.3.17.2A	3.4	R/F
51N	51N0672	126	106	72	170	60-120	2.3.17.2A	2.2	R/F
51N	51N0666	126	106	66	170	60-120	2.3.17.2A	1.7	R/F
51N	51N8065	126	1080	65	170	60-120	2.3.17.2A	3.2	R/F
51N	51N8060	126	1080	60	170	60-120	2.3.17.2A	2.7	R/F
37N	37N0666	42	106	66	200	70-100	2.3.17.2A	1.8	HS
37N	37N066601	42	106	66	200	100-130	2.3.17.2A	1.8	R/F
37N	37N066606	42	106	66	200	4-8%	2.3.17C	1.8	R/F
37N	37N8060	42	1080	60	200	70-100	2.3.17.2A	3.0	HS
37N	37N806001	42	1080	60	200	100-130	2.3.17.2A	3.0	R/F
37N	37N806006	42	1080	60	200	4-8%	2.3.17C	3.0	R/F
38N	38N0666	42	106	66	200	70-120	2.3.17.2A	2.0	R/F, HS
38N	38N8060	42	1080	60	200	70-120	2.3.17.2A	3.0	R/F, HS

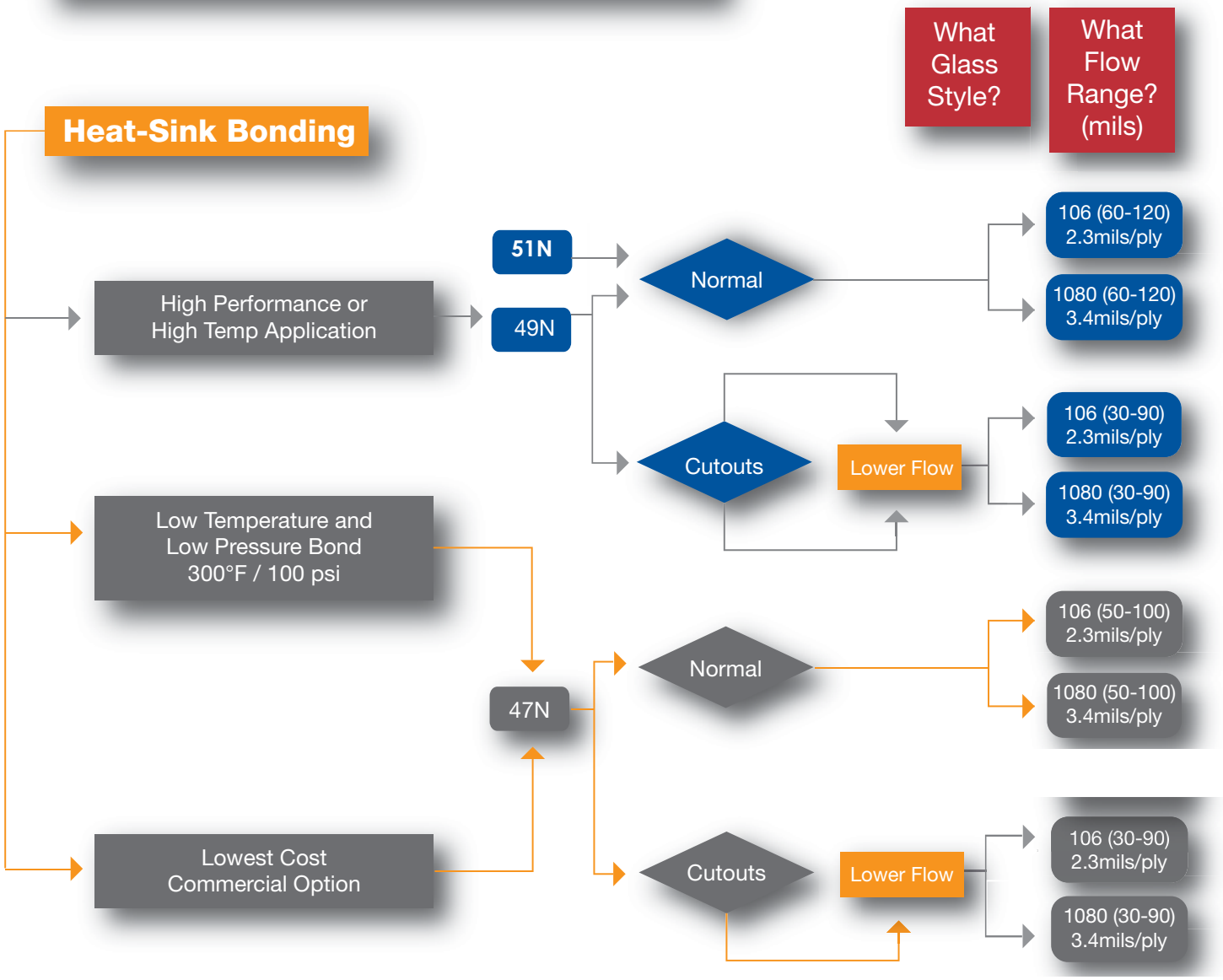
Arlon Low-Flow Application Selection Guide



In general, for rigid flex, use higher flow only when heavier copper fill is needed.

In general, for heat sinks, use medium flow except in the case when there are several cutouts, when a low flow may be preferred.

Arlon Low-Flow Application Selection Guide



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ELECTRONIC MATERIALS

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