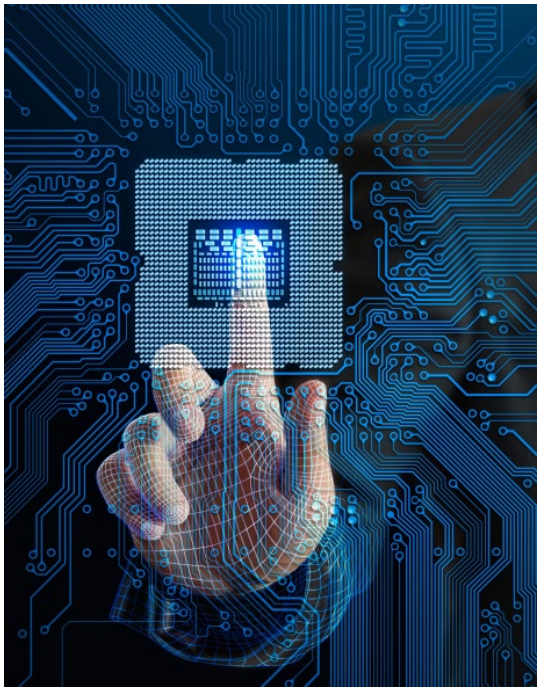
# Encapsulating Harsh-environment Devices



DOWSIL™ TC-6020 Thermally Conductive Encapsulant *

*Product currently only available for sale in China, ASEAN, Japan, Europe

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Imagine

# DOWSIL™ TC-6020 Thermally Conductive Encapsulant

## Features

- Two-part with 1:1 mix ratio
- Good flowability for easy processing
- Fast curing with moderate heat
- High thermal conductivity: 2.72 W/m*K
- Firm and strong with low elongation
- Excellent dielectric properties
- Wide service-temperature range

## Potential Applications

- Electric vehicle control units
- Power inverters/converters
- Controller/driver modules
- Power supplies

## Process

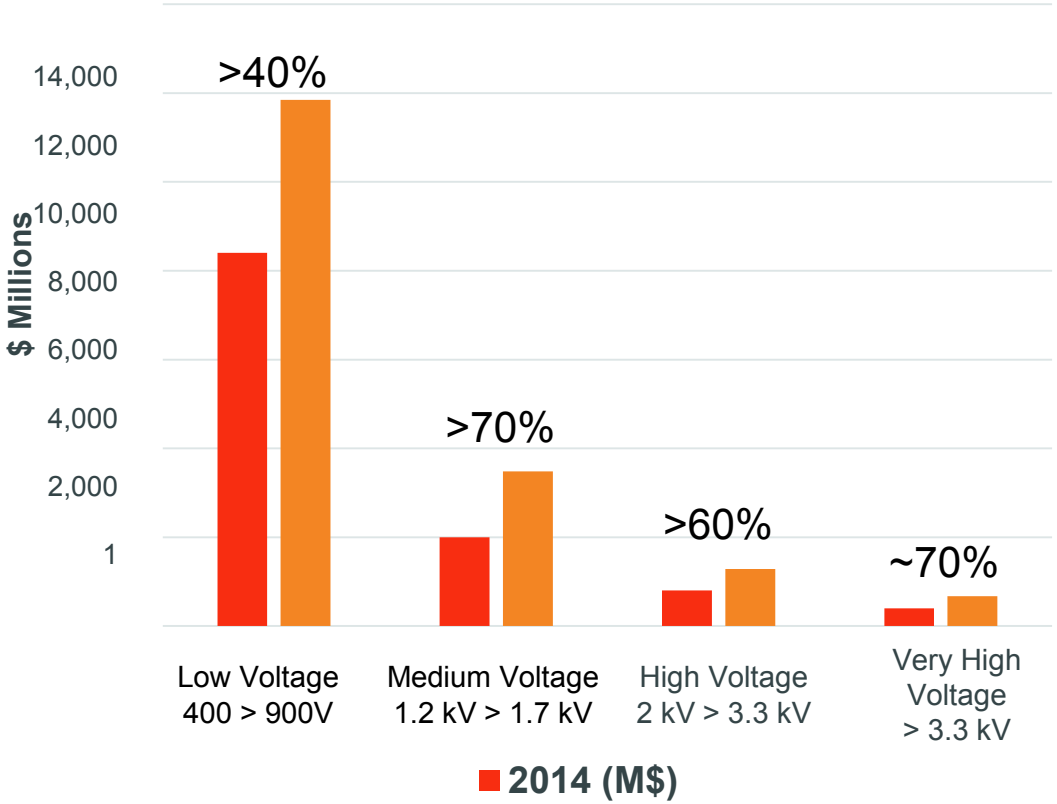
- Manual or automated dispensing

## Benefits to Customer

- Efficient process for high throughput
- Long-term reliability

# Market Information – Power Conversion

**Power Conversion, By Voltage (2014-2020) Outlook (Rev$)***




*Source: Market and Technology Trends in WGB material for Power Electronics Applications, CS mantech Con. 2015

**Source: Prismark 2016 Report and Status of Power Electronics Industry 2015 by Yole

## Key growth opportunities before 2020**

- Global power inverter market: $43B in 2013, CAGR 6.5% to 2020
- The growth of the power inverter market is driven by three key end-market trends:
  - Renewable energy
  - Electrification of automobile and mass transportation
  - Smart grid implementation
- Some high growth, sub-segments (inverter in):
  - Rail traction: +5.2%
  - EV/HEV, EV/HEV charger: +15%
  - Motor drives: +8%
  - High power base station: +40%

# Power Inverter Trends and Requirement to Protection Solution

## Power inverter needs

- Smaller, lighter, integrated
- Improved heat dissipation efficiency
- Longer product life cycle
- Work in harsh environment

## Requirements for encapsulants

- **Performance** – Both electrical and heat
- **Reliability** – Regulatory and industrial standard
- **Processability** – Enable “smart” design

DOWSIL™ TC-6020 Thermally Conductive Encapsulant can aid process efficiency for control modules and power supplies.

High voltage power supply, EV charger and EV inductance coil may share the same needs.

# Overview

DOWSIL™ TC-6020 Encapsulant is a two-part (1:1 mix ratio) encapsulant with high thermal conductivity 2.7 W/m*K, good flowability and room temperature cure to improve manufacturing productivity.

| Features | Benefits |
|---|---|
| • Two-part with 1:1 mix ratio<br>• Good flowability for easy processing<br>• Fast curing with moderate heat | • Efficient process for high throughput |
| • High thermal conductivity: 2.72 W/m*K | • Effective heat dissipation from device |
| • Firm and strong with low elongation<br>• Excellent dielectric properties<br>• Wide service-temperature range | • Good protection of devices exposed to harsh environments |

# Packaging and Sampling Information

| SAP # | Product | Remark |
|---|---|---|
| 04126617 | DOWSIL™ TC-6020 Encapsulant Part A, kg, 10-kg pail | |
| 04126618 | DOWSIL™ TC-6020 Encapsulant Part B, kg, 10-kg pail | |
| 04127220 | DOWSIL™ TC-6020 Encapsulant Part A, kg, 1-kg can | Sample SKU |
| 04127219 | DOWSIL™ TC-6020 Encapsulant Part B, kg, 1-kg can | Sample SKU |

- **Packaging:** 10 kg pail and 1 kg can
- **Shelf Life:** 9 months
- **Storage Condition**: < 50ºC
- **Manufacturing Site:** SongJiang, China
- **Sales Territory:** Global

# Technical Information

# Comparison Between DOWSIL™ Encapsulants and Competitor

| Property | Unit | DOWSIL™ CN-8760 Encapsulant | DOWSIL™ TC-6011 Encapsulant | DOWSIL™ TC-6020 Encapsulant | External Benchmark |
|---|---|---|---|---|---|
| **Viscosity (Part A)** | cP | 2,400 | 3,200 | 10,800 | 24,640 |
| **Viscosity (Part B)** | cP | 2,397 | 2,400 | 9,960 | 20,800 |
| **Viscosity (Mixed)** | cP | 2,850 | 3,000 | 10,640 | |
| **Thermal Conductivity** | W/mk | 0.66 | 1.0 | 2.72 | 2.6 |
| **Specific Gravity (Cured)** | $g/cm^3$ | 1.60 | 1.65 | 2.926 | 3 |
| **Pot Life (25˚C)** | minutes | 120 | 135 | 77 | 40 |
| **RT Cure Time (25˚C)** | hours | 16 | - | 24 | |
| **Heat Cure Time (80˚C), T90** | minutes | 10[1] | 60 | 13 | 2[2] |
| **Durometer** | Shore A | 52 | 28 | 63 | 46 |
| **Dielectric Strength** | kV/mm | 26 | 21 | 24.1 | |

1. Heat cure under 85ºC 2. Heat cure under 100ºC

# Processability

## Viscosity

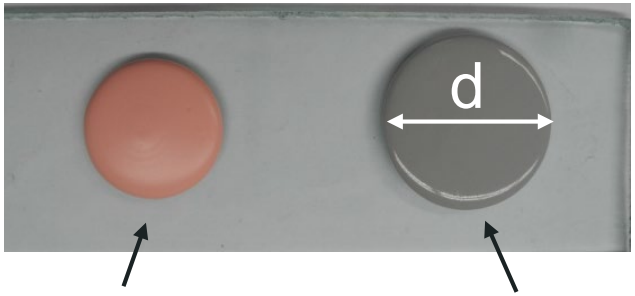
(Brookfiled spindle 3# at 20 RPM)

- Part A 10800 cP
- Part B 9900 cP
- Mixed 10640 cP

## Flow

- Horizontal flow on glass
  d = 37 mm (1 mL of DOWSIL™ TC-6020 Encapsulant)
- Slope flow (5º)
  L = 18 cm (2 mL of DOWSIL™ TC-6020 Encapsulant)

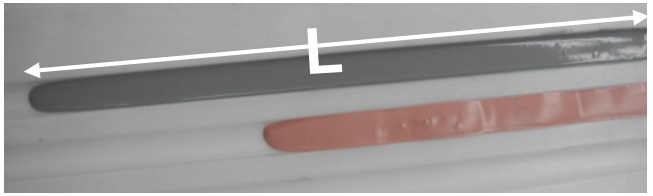
**Horizontal Flow**




**Competitive Product**

**DOWSIL™ TC-6020 Encapsulant**

**Slope Flow**

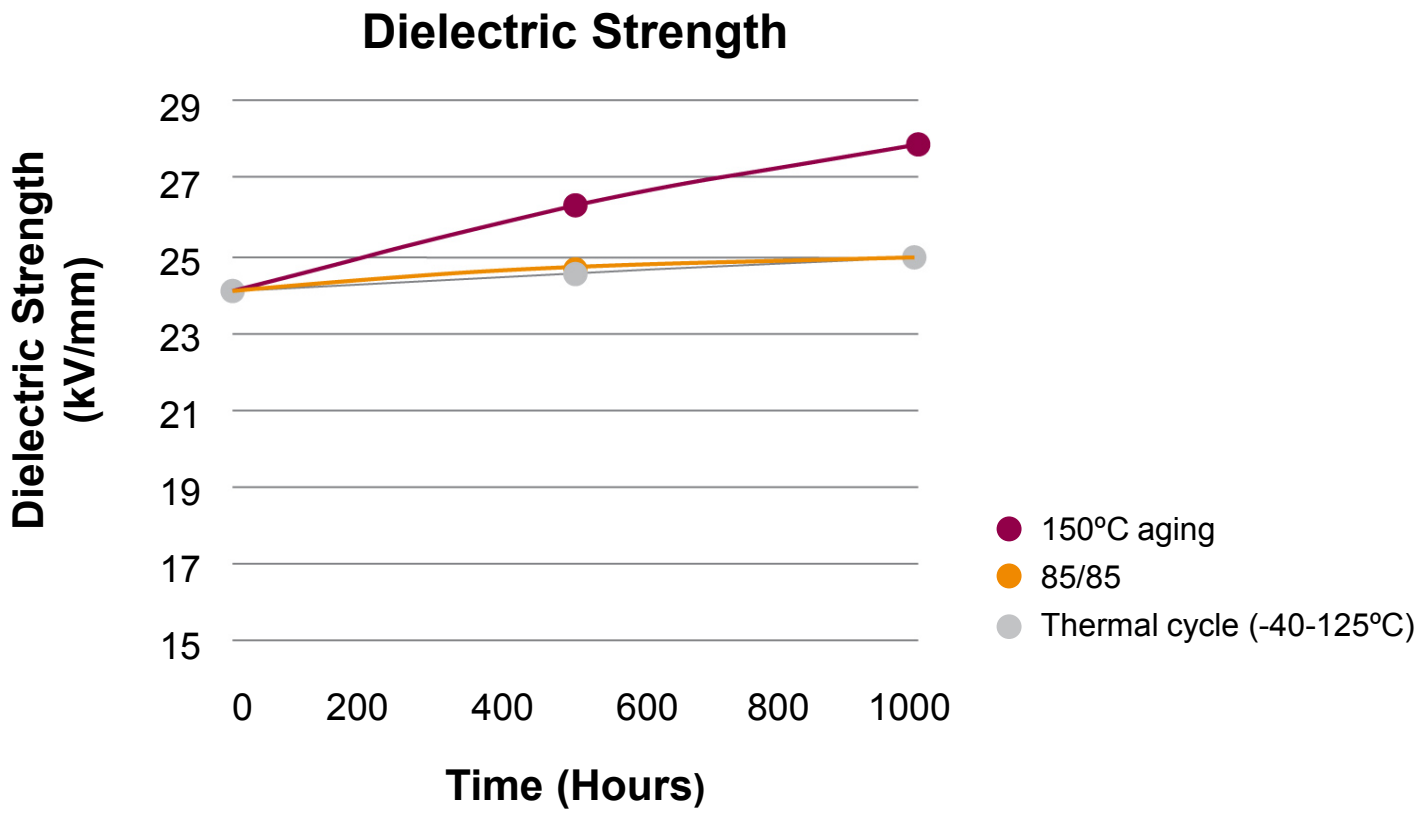



**DOWSIL™ TC-6020 Encapsulant**

**Competitive Product**

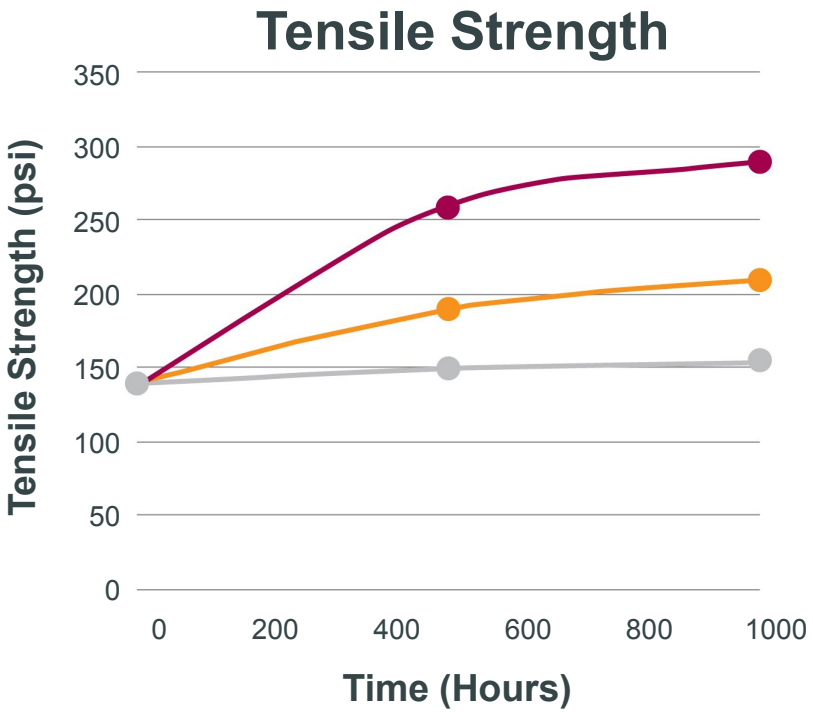
# Reliability – Dielectric Strength

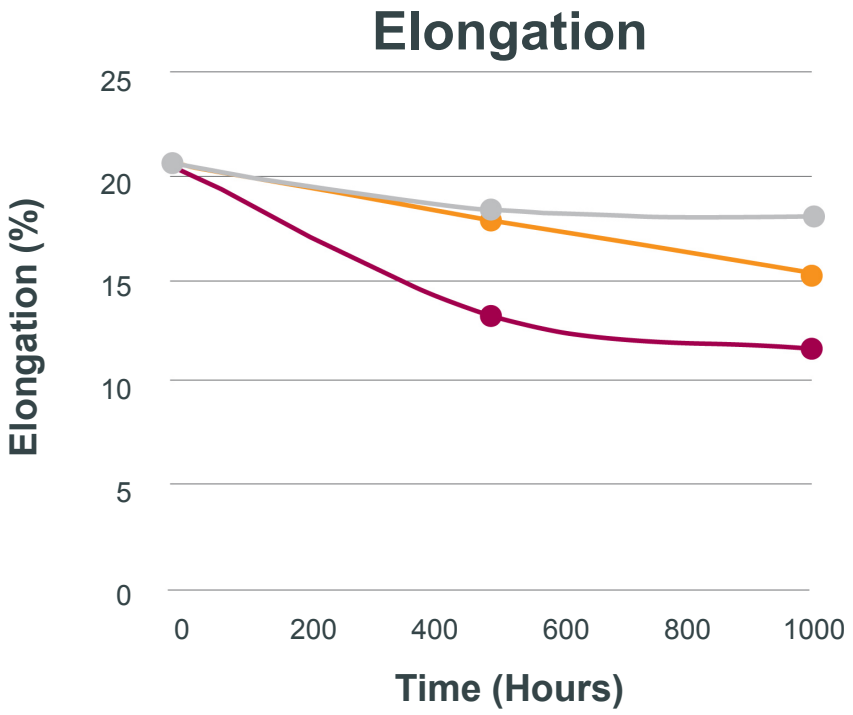
DOWSIL™ TC-6020 Thermally Conductive Encapsulant: proven stable dielectric strength during reliability test.



# Reliability – Tensile Strength and Elongation

**DOWSIL™ TC-6020 Thermally Conductive Encapsulant** Tensile strength increased and elongation decreased during reliability test.



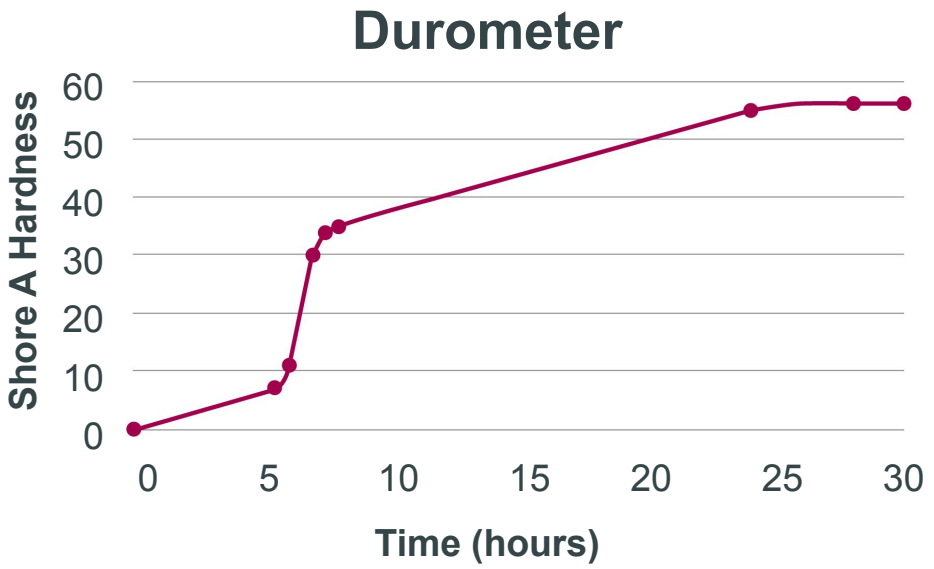




- 150ºC baking
- 85/85
- Thermal cycle (-40-125ºC)

# Cure Profile

## DOWSIL™ TC-6020 Thermally Conductive Encapsulant

- Can be cured at room temperature;
- Slightly improved cure temperature can shorten curing time.




| | |
|---|---|
| **Cure at 60°C, T90, min, MDR2000** | 23.18 |
| **Cure at 80°C, T90, min, MDR2000** | 13.04 |
| **Cure at 100°C, T90, min, MDR2000** | 4.98 |

# DOWSIL™ TC-6020 Thermally Conductive Encapsulant – Summary

- High thermal conductivity 2.7 W/m*K is a key feature, compared with other DOWSIL™ encapsulants
- Good flowability is a key advantage compared with competitive encapsulants
- Cures at room temperature
- Provides stable reliability performance – dielectric strength, tensile strength and elongation – up to 1000 hours
- GY color version is certified UL 94 V-0 of 3-3.5 mm, RTI 150ºC
- Two packages available: 10-kg pail and 1-kg can

# Learn More

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# Thank You



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