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## Kaladex 2000 PEN film

Kaladex® 2000 is a biaxially oriented polyethylene naphthalate (PEN) film. PEN is a high-performance polyester offering improved mechanical, thermal and chemical properties compared with conventional polyethylene terephthalate (PET) films, while maintaining good processing characteristics.

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### Attributes

Kaladex® 2000 combines high mechanical strength with excellent heat and hydrolysis resistance, good dimensional stability and low oligomer extraction. This balanced property profile makes the film suitable for applications with demanding thermal, mechanical and electrical requirements.

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### Application

Kaladex® 2000 is used in a wide range of electrical and electronic applications, including insulation for motors and transformers, capacitors, flexible printed circuits and fuel cells. PEN is particularly suitable for applications where conventional PET films reach their performance limits, but the full performance capabilities of polyimide (PI) films are not necessary. This makes PEN a cost-effective material solution for applications requiring a higher performance level than PET without the need for PI.

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### Standards

- Class F (155 °C) insulating material
- UL listed, File No. E93687
- RoHS compliant according to 2011/65/EU

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### Delivery forms

#### Total thickness in µm:

- 25, 38, 50, 75, 100

#### Kaladex® 2000 is available:

- in tapes from 6 mm width
- in rolls approx. 1,000 mm wide

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### Base

Polyethylene naphthalate (PEN)

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| <b>Mechanical</b>                  | Unit of measure    |      |      |      |      |      |
|------------------------------------|--------------------|------|------|------|------|------|
| Nominal thickness                  | µm                 | 25   | 38   | 50   | 75   | 100  |
| F5-value longitudinal (MD)         | kg/mm <sup>2</sup> | 15   | 15   | 15   | 15   | 15   |
| F5-value, transversal (CMD)        | kg/mm <sup>2</sup> | 16   | 16   | 16   | 16   | 16   |
| Tensile strength longitudinal (MD) | kg/mm <sup>2</sup> | 25   | 25   | 25   | 25   | 25   |
| Tensile strength transversal (CMD) | kg/mm <sup>2</sup> | 28   | 28   | 28   | 28   |      |
| Elongation at break longitudinal   | %                  | 90   | 90   | 90   | 90   | 90   |
| Elongation at break transversal    | %                  | 65   | 65   | 65   | 65   | 65   |
| Density                            | g/cm <sup>2</sup>  | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 |

| <b>Optical</b>    | Unit of measure |    |
|-------------------|-----------------|----|
| Nominal thickness | µm              | 25 |
| Haze              | %               | 6  |

| <b>Optical</b>    | Unit of measure |    |    |    |     |
|-------------------|-----------------|----|----|----|-----|
| Nominal thickness | µm              | 38 | 50 | 75 | 100 |

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| Optical | Unit of measure |   |    |    |    |
|---------|-----------------|---|----|----|----|
| Haze    | %               | 8 | 13 | 18 | 25 |

| Thermal                                            | Unit of measure      |     |     |     |     |     |
|----------------------------------------------------|----------------------|-----|-----|-----|-----|-----|
| Nominal thickness                                  | µm                   | 25  | 38  | 50  | 75  | 100 |
| Fusion temperature                                 | °C                   | 269 | 269 | 269 | 269 | 269 |
| Glass transition temperature                       | °C                   | 121 | 121 | 121 | 121 | 121 |
| Shrinkage longitudinal (MD) / 190 °C, 5 min        | %                    | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| Shrinkage transversal (CMD) / 190 °C, 5 min        | %                    | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 |
| Shrinkage longitudinal (MD) / 150 °C, 30 min.      | %                    | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| Shrinkage transversal (CMD) / 150 °C, 3 min.       | %                    | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| Coefficient of thermal expansion longitudinal (MD) | 10 <sup>-6</sup> /°C | 13  | 13  | 13  | 13  | 13  |
| Coefficient of thermal expansion transversal (CMD) | 10 <sup>-6</sup> /°C | 13  | 13  | 13  | 13  | 13  |

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| Thermal                                             | Unit of measure       |     |     |     |     |     |
|-----------------------------------------------------|-----------------------|-----|-----|-----|-----|-----|
| Hygroscopic expansion coefficient longitudinal (MD) | 10 <sup>-6</sup> /%RH | 11  | 11  | 11  | 11  | 11  |
| Hygroscopic expansion coefficient transversal (CMD) | 10 <sup>-6</sup> /%RH | 11  | 11  | 11  | 11  | 11  |
| Mechanical RTI                                      | °C                    | 160 | 160 | 160 | 160 | 160 |
| Electrical RTI                                      | °C                    | 180 | 180 | 180 | 180 | 180 |

| Electrical          | Unit of measure |     |
|---------------------|-----------------|-----|
| Nominal thickness   | µm              | 25  |
| Dielectric strength | kV/mm           | 331 |

| Electrical          | Unit of measure |     |     |     |     |
|---------------------|-----------------|-----|-----|-----|-----|
| Nominal thickness   | µm              | 38  | 50  | 75  | 100 |
| Dielectric strength | kV/mm           | 261 | 248 | 198 | 187 |

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