

## Technical report 电气性能测试报告

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Geißler, Michael	+49 911 434 2795		ERT-2018-25-C
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## Electrical properties of laminated wood KP20222 (C2R) made of birch from Zhalantun Tongde (China)

### 扎兰屯同德桦木材质层压木 KP20222 (C2R)电气性能测试报告

#### 1. Summary 概述

The measured KP 20222 material from Zhalantun Tongde shows an acceptable quality according TUN 901074 for Traction, DT-Transformers and 110kV-Transformers.

From the electrical point of view the material should be limited like other material made from birch to AC=230kV, LI=550kV test voltage level.

扎兰屯同德的 KP 20222 材料按照西门子层压木供货技术条件 TUN 901074 进行了测试，其结果满足牵引变，配电变压器及 110KV 变压器的质量要求。

从电气性能测试结果来看，该桦木质材料像其他桦木材质的材料可用于 AC=230kV, LI=550kV 试验电压水平。

## 2. Measurements 测量

Partial discharge (PD) measurements were tested at the High Voltage Laboratory in Nürnberg. The measurements are carried out in a homogeneous field with a clearance between the electrodes of 30mm. The specimen dimension was of 50 mm x 30 mm x 50 mm.

在德国纽伦堡西门子高压试验室进行了局放测试。测试是在电极间隙 30 毫米的均匀场强下进行。样品尺寸为 50x30x50 毫米。

Test Nr.	Spec. Nr.	PD inception 局放爬电		Breakdown 击穿		Event	Loc in case of PD
		V <sub>pd</sub> [KV]	E <sub>pd</sub> [KV/mm]	V <sub>bd</sub> [KV]	E <sub>bd</sub> [KV/mm]		
1	8			100,0	3,3	BD	-
2	18	120,0	4,0	150,0	5,0	PD	BD
3	17	90,0	3,0	140,0	4,7	PD	BD
4	15	-	-	100,0	3,3	BD	-
5	16	-	-	120,0	4,0	BD	-
6	11	120,0	4,0	120,0	4,0	PD	FS
7	20	-	-	130,0	4,3	BD	-
8	19	-	-	130,0	4,3	BD	-
9	10	140,0	4,7	190,0	6,3	PD	BD
10	12	-	-	140,0	4,7	BD	-
11	1	-	-	110,0	3,7	BD	-
12	4	110,0	3,7	150,0	5,0	PD	BD
13	3	140,0	4,7	140,0	4,7	PD	BD
14	5	130,0	4,3	150,0	5,0	PD	BD
15	2	-	-	110,0	3,7	FS	-

## 3. Results 结论

According to our requirements, the minimum PD inception voltage and/or breakdown voltage is important. The laminated wood C2R (made from birch) from Zhalantun Tongde fulfills requirements acc.TUN 901074 for Traction, DT-Transformers and 110kV-Transformers.

From the electrical point of view the material should be limited like other material made from birch to AC=230kV, LI=550kV test voltage level.

按照西门子要求，最小的局放放电电压及/或击穿电压非常重要。扎兰屯同德的 C2R 层压木（桦木材质）满足牵引变、配电变压器及 110KV 变压器基于西门子层压木供货技术条件 TUN 901074 的要求。

从电气角度，该材料像其他桦木质层压木可用于 AC=230kV, LI=550kV 试验电压水平。



Geißler, Michael  
EM TR LPT GTC R&D-H ERT  
GCT Insulation Materials

**Test report 测试报告**

**Protection Class: Unrestricted**

<u>Address</u> Katzwanger str. 150 90461 Nürnberg	<u>Department</u> EM TS CS TR ML	<u>Phone</u> +49 911 434-2384	<u>Ref.</u> ML150-18
<u>Editor</u> Meth	<u>Countersign</u> Zafeiris	<u>Date</u> 15.06.2018	<u>Page</u> 1 of 3
<u>Address / customer</u> Sun, Wei <sunwei.stcl@siemens.com>		<u>sample reception</u> 29.05.2018	
<u>Distribution list</u> Schleyerback, Alexander		Breitfelder, Dieter	EM TS CS TR ML
Bao, Han		Chen, Zheng	

**Testing of mechanical and physical properties of laminated wood C2B (birch) from supplier ZhaLanTun**  
供货商扎兰屯 C2B (桦木) 层压木机械及物理性能测试结果

**Summary 概述**

The mechanical and physical properties of the laminated wood C2B (Birch) fulfills to the requirements of the IEC61061 and TPS 9.8.25 - TUN 901074 standard.

C2B(桦木)层压木机械及物理性能测试结果符合 IEC61061 及西门子层压木采购规范 TPS 9.8.25 - TUN 901074 要求。

**1. Cause of Study 测试原因**

The laminated wood C2B (birch) from the supplier ZhaLanTun shall be tested according to IEC 61061 and TUN 901074 for application in oil immersed transformers.

扎兰屯 C2B(桦木)层压木如用于西门子设计的油浸式变压器应按照 IEC61061 及层压木供货技术条件 TUN 901074 进行测试。

**2. Tests 测试**

The laminated wood samples were tested according to IEC 61061-2 and TPS 9.8.25-TUN 901074. The following physical and mechanical tests have been carried out:

扎兰屯层压木样品按照 IEC61061-2 及西门子层压木采购规范 TPS 9.8.25 - TUN 901074 要求进行了如下机械及物理性能测试，

- Thickness<sup>1</sup> 厚度
- Apparent density<sup>1</sup> 表观密度
- Number of veneers<sup>1</sup> 每公分厚度上单片数量
- Flexural strength perpendicular to the laminations at RT and 90°C<sup>2</sup>  
室温及 90°C<sup>2</sup> 下垂直于层压方向的抗弯强度
- Modulus of elasticity perpendicular to the laminations at RT and 90°C<sup>2</sup>  
室温及 90°C<sup>2</sup> 垂直于层压方向的弹性模量
- Compressive strength perpendicular and parallel to the laminations at RT and 90°C<sup>2</sup>  
室温及 90°C<sup>2</sup> 垂直及平行于层压方向的压缩强度
- Compressibility at RT<sup>2</sup> 室温下的压缩性
- Impact strength at RT<sup>2</sup> 室温下的冲击强度

- Shearing strength<sup>1</sup> 抗剪强度
- Shrinkage in (MD) and cross machine direction (CMD)<sup>1</sup> 纵、横向收缩
- Moisture content in delivery state 交付状态下的含水量
- Oil absorption<sup>1</sup> 吸油率
- Oil compatibility with mineral oil 与矿物油的相容性

<sup>1</sup> Not in the scope of accreditation 不在认证范围内

<sup>2</sup> Subcontracting 分包

Color (ISO 2049) 颜色  
 Purity (IEC 60422) 纯度  
 Neutralization number (IEC 62021-2) 中和值  
 Dielectric loss factor 90°C (IEC 60247) 90°C 下介损  
 Water content (IEC 60814) 微水含量  
 Interfacial tension (ISO 6295) 界面张力

Furthermore, a sample of the dimension 250x250x50mm has been dried in a vapor phase drying oven. After that, it was analyzed concerning delamination and cracks.

此外，250x250x50mm 的一块样品在气象干燥罐内进行了烘干测试，烘干后就是否分层级开裂进行了分析。

### 3. Results and Evaluation 结果及评估

The mechanical and physical values can be found in table 1. 机械及物理性能测试值参加表 1

**Tab. 1:** Results of the measurements from the laminated wood C2B  
 C2B 层压木测试结果

<i>Test 测试项目</i>	<i>Measured values 测量结果</i>	<i>Required values* 要求值</i>
Thickness [mm] 厚度	22	20 ± 2
Apparent density [g/cm <sup>3</sup> ] 表观密度	0,9	0,9 – 1,1
Number of veneers/cm 每公分厚度上单片数量	9	≥ 7
Flexural strength at RT [MPa] MD 室温下纵向抗弯强度	158	≥ 55
Flexural strength at RT [MPa] CMD 室温下横向抗弯强度	119	≥ 55
Flexural strength at 90°C [%] MD 90°C 纵向抗弯强度	-15	Max. 40 % decrease
Flexural strength at 90°C [%] CMD 90°C 横向抗弯强度	-7	Max. 40 % decrease
Modulus of elasticity at RT [GPa] MD 室温下纵向弹性模量	14	≥ 6
Modulus of elasticity at RT [GPa] CMD 室温下横向弹性模量	12	≥ 6
Modulus of elasticity at 90°C [%] MD 90°C 下纵向弹性模量	-10	Max. 35% decrease

Modulus of elasticity at 90°C [%] CMD 90°C 下横向弹性模量	-4	Max. 35% decrease
Compressive strength perpendicular RT [MPa] 室温下垂直于层压方向的压缩	238	≥ 140
Compressive strength perpendicular 90°C [%] 90°C 下垂直于层压方向的压缩	-17	Max. 20% decrease
Compressive strength parallel RT [MPa] 室温下平行于层压方向的压缩	75	≥ 60
Compressive strength parallel 90°C [%] 90°C 下平行于层压方向的压缩	-17	Max. 20 % decrease
Compressibility [%] C C <sub>rev</sub> 压缩性	3 88	≤ 4 ≥ 70
Impact strength [KJ/m <sup>2</sup> ] MD 纵向冲击强度	27	≥ 10
Impact strength [KJ/m <sup>2</sup> ] CMD 横向冲击强度	40	≥ 10
Shearing strength [MPa] 抗剪强度	7	≥ 7
Shrinkage [%] MD 纵向 收缩 CMD 横向 Thickness 厚度方向	0,1 0,1 3,0	≤ 0,3 ≤ 0,3 ≤ 3
Moisture [%] 含水量	6	≤ 6
Oil absorption [%] 吸油率	17	≥ 15

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### Oil Compatibility 与变压器油的相容性

Color [-] 颜色	<0,5	0,5
Purity [-] 纯度	clear	Clear
Neutralization value [mgKOH/g <sub>oil</sub> ] -value 中和值	0,01	<0,03
Dielectric loss factor [-] -value 介损	<0,001	0,010
Water content -value in [%] 含水量	8	50%
Interfacial Tension [mN/m] 界面张力	36	≥35

\*According to IEC 61061-3-1 and TPS 9.8.25 - TUN 901074 for the type C2R

After the vapor phase drying, neither cracks nor delamination were detected.  
气象干燥后未发现分层及开裂

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**Meth**  
**M.Sc. - Chemistry**  
**Material testing**

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**Zafeiris**  
**Dipl. - Ing.(UAS) - Chemistry**  
**Material testing**

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