演讲者简介：

周树东，广州市宝力达电气材料有限公司总经理，高级工程师，1990年高分子化学硕士毕业, 从株州电力机车所绝缘室开始研发生产无溶剂真空绝缘树脂，有长期从事聚合物合成，测试及应用的经验，是电工绝缘材料，电气绝缘结构的专家。拥有发明专利4项, 多次制修订国家标准, 近年来特别关注聚合物材料在光伏领域的应用。

- The speaker's brief introduction:
- Shudong Zhou, General manager of Guangzhou Bothleader Electrical Materials Co., Ltd., senior engineer, graduated as a master of polymer chemistry in 1990, then developped and produced vacuum insulation resin in ZhuZhou electric locomotive insulation department, up to now, has long been engaged in polymer synthesis, test and application, is an expert in the field of the electrical insulation materials, electrical insulation structure. Have 4 invention patents, and revised the national standard for many times, in recent years, pay special attention to the application of polymer materials in photovoltaic (pv).

组件质量:封装是关键
Modules Quality: Encapsulation is the Key

前言：近年来,光伏企业越来越多，光伏组件的各种质量问题已经开始出现，如玻璃中NA^{+}的迁移，PID，热斑，蜗牛纹等，事实上只有认清组件的本质才能有效预防和解决质量隐患。

Foreword: In recent years, more and more enterprises PV have been born, and various quality problems of photovoltaic modules begin to emerge, such as the migration of glass NA^{+} , PID, hot spots, snails trails, etc., the fact that only recognize the nature of the components that can effectively prevent and resolve quality problems.

内容提纲

1. 导体半导体绝缘材料的区别及特点
2. 光对材料的作用
3. 光伏不等于太阳能发电
4. 绝缘材料是地面太阳能发电的关键
5. EVA固化体系

1.导体半导体与绝缘材料

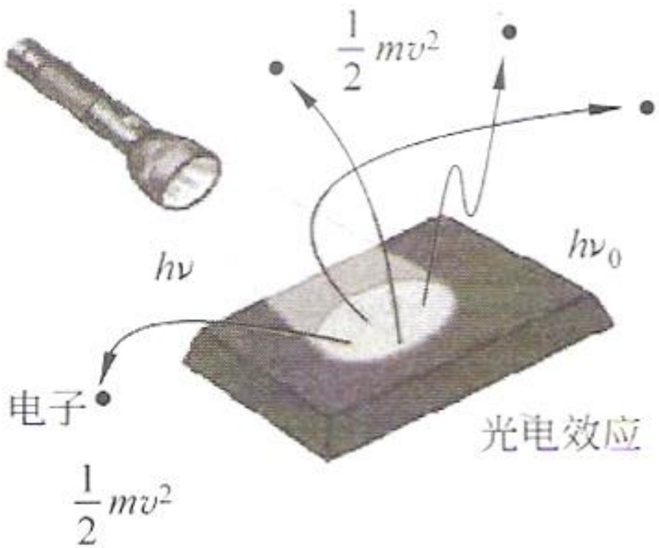
- 不同的物体允许电流通过的能力叫做物体的导电性能。
  通常把电阻率小的（小于10万分之一,10负5次方欧姆米）、导电性能好的物体叫做导体。

  电阻率很大的（大于10~8欧姆·米）、导电性能很差的物体叫做绝缘体。陶瓷、云母、玻璃、橡胶、塑料、电木、纸及层压板、树脂等物体，都是绝缘体（也叫电介质)
-
  导电性能介于导体和绝缘体之间的物体叫做半导体。硅、锗、硒等都可以制半导体。半导体在电子领域应用越来越广泛。它有光敏性(电阻,光伏)和热敏性.(工作温度不能过高,高温下电阻率会变化)

- 在元素周期表上,金属为导体,类金属为半导体,碳氢氧等非金属组成千万种聚合物,是绝缘材料,-----所有电子电工产品都是由这几类材料构成.

2.光对材料的作用

光对导体：光电效应



$$\boxed{h\nu = h\nu_0 + \frac{1}{2}mv^2}$$

h=普朗克常数

v=电子速度

ν=光量子频率

ν_0=频率阀值

m=电子质量

光电效应的量子解释

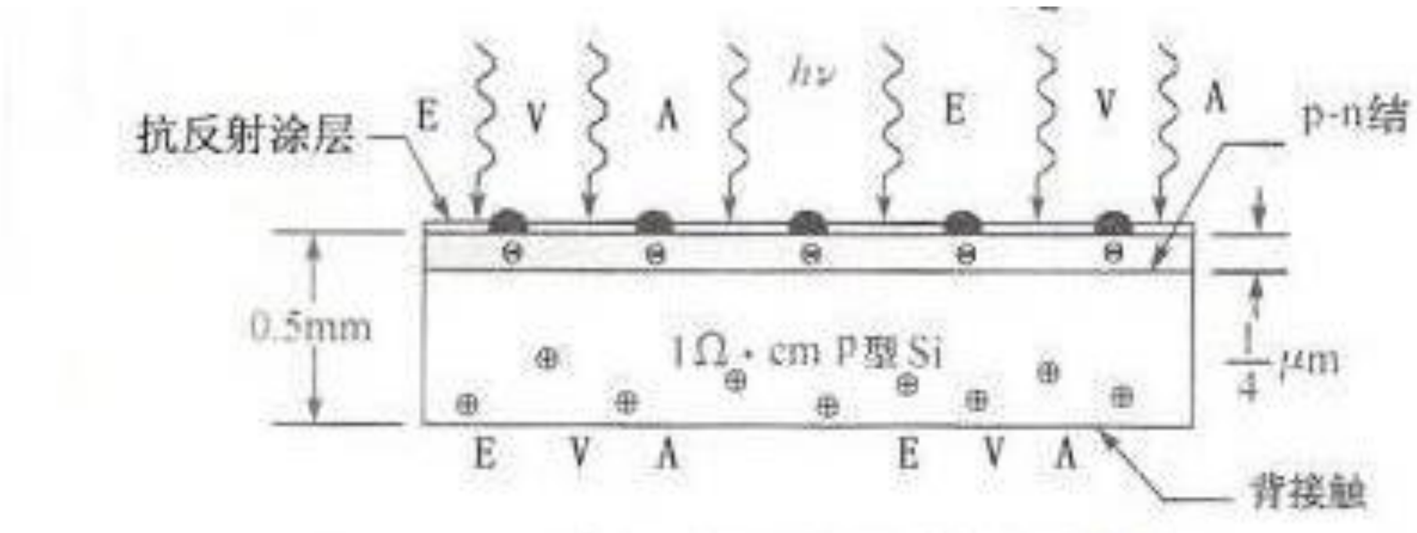
光对半导体：光伏效应

硅的纯度：冶炼级99.9%

光伏级99.9999%-——99.9999999%

电子级99.99999999%

它们都属于绝缘材料，但在掺入万分之一的硼，磷后电阻率会下降几个数量级变成半导体。硅片一面掺硼，一面掺磷形成PN结，在光照下就形成电势差。

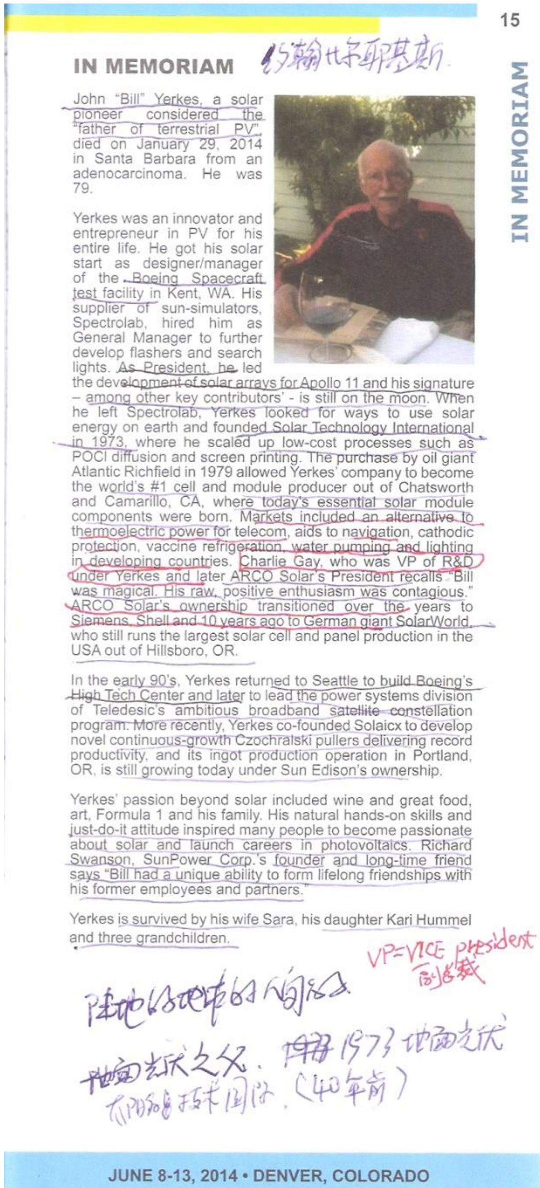


硅 p-n 结太阳能电池的示意图

光对高分子绝缘材料：光老化效应

长期的光照会导致高分子材料发生一系列的变化，光学性能如黄变，机械性能如脆化等，电性能下降而击穿。颜色加深是材料老化的表面现象，但不变色不代表材料没有老化。

3.光伏不等于太阳能发电



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IN MEMORIAM

约翰比尔耶基斯

John "Bill" Yerkes, a solar pioneer considered the "father of terrestrial PV", died on January 29, 2014 in Santa Barbara from an adenocarcinoma. He was 79.

Yerkes was an innovator and entrepreneur in PV for his entire life. He got his solar start as designer/manager of the Boeing Spacecraft test facility in Kent, WA. His supplier of sun-simulators, Spectrolab, hired him as General Manager to further develop flashers and search lights. As President, he led the development of solar arrays for Apollo 11 and his signature – among other key contributors' - is still on the moon. When he left Spectrolab, Yerkes looked for ways to use solar energy on earth and founded Solar Technology International in 1973, where he scaled up low-cost processes such as POCl diffusion and screen printing. The purchase by oil giant Atlantic Richfield in 1979 allowed Yerkes' company to become the world's #1 cell and module producer out of Chatsworth and Camarillo, CA, where today's essential solar module components were born. Markets included an alternative to thermoelectric power for telecom, aids to navigation, cathodic protection, vaccine refrigeration, water pumping and lighting in developing countries. Charlie Gay, who was VP of R&D under Yerkes and later ARCO Solar's President recalls "Bill was magical. His raw, positive enthusiasm was contagious." ARCO Solar's ownership transitioned over the years to Siemens, Shell and 10 years ago to German giant SolarWorld, who still runs the largest solar cell and panel production in the USA out of Hillsboro, OR.

In the early 90's, Yerkes returned to Seattle to build Boeing's High Tech Center and later to lead the power systems division of Teledesic's ambitious broadband satellite constellation program. More recently, Yerkes co-founded Solaicx to develop novel continuous-growth Czochralski pullers delivering record productivity, and its ingot production operation in Portland, OR, is still growing today under Sun Edison's ownership.

Yerkes' passion beyond solar included wine and great food, art, Formula 1 and his family. His natural hands-on skills and just-do-it attitude inspired many people to become passionate about solar and launch careers in photovoltaics. Richard Swanson, SunPower Corp.'s founder and long-time friend says "Bill had a unique ability to form lifelong friendships with his former employees and partners."

Yerkes is survived by his wife Sara, his daughter Kari Hummel and three grandchildren.

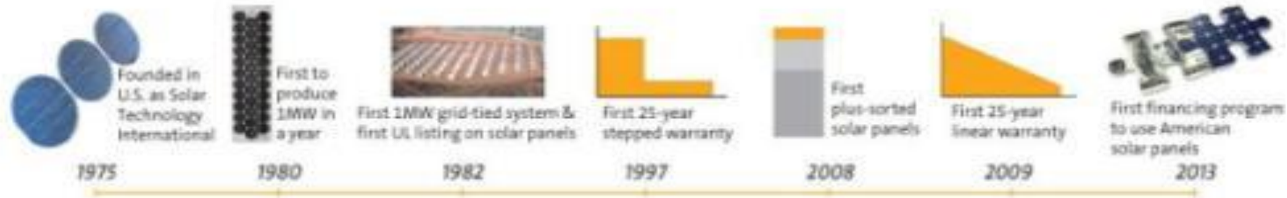
VP=VICE president 副总裁

地面光伏之父. 1973 地面光伏 太阳能技术国际. (40年前)

JUNE 8-13, 2014 • DENVER, COLORADO

从第一颗卫星上天开始，太阳能发电得到应用。约翰比尔耶基斯是被誉为“地球光伏之父”的太阳能先驱，他设计的卫星电池组件让人类成功登月。从1973年开始，耶基斯寻求太阳能发电在地面上的应用，并建立了国际太阳能技术公司，即现在的SOLAR WORLD.

Timeline of Solar Industry Firsts



Complete History

1975

Engineer and entrepreneur Bill Yerkes creates Solar Technology International

工程师和企业家比尔耶基斯创建国际太阳能技术

1977

太阳能技术国际收购大西洋里奇菲尔德，形成 ARCO 太阳能有限公司

1979

In Camarillo, Calif., ARCO Solar dedicates world's largest PV factory to making silicon crystal ingots, wafers, photovoltaic cells and modules. 加利福尼亚州卡马里奥市 **ARCO** 太阳能献给世界上最大的光伏组件工厂制作硅晶锭、 硅片、 光伏电池和模块。

1980

ARCO 太阳能成为第一家公司在一年之内产生超过 1 兆瓦的光伏组件

1982

ARCO Solar commissions world's first 1 MW grid-connected PV installation

1985

Australia's University of New South Wales creates silicon cells with 20% efficiency in laboratory

1990

西门子收购 ARCO 太阳能、 形成西门子太阳能

1996

西门子太阳能庆祝 **100** 兆瓦的装机容量从模块在卡马里奥

1997

西门子公司成为第一家公司提供 25 年保修

1998

SolarWorld 形式作为启动业务，进入德国的蓬勃发展的太阳能市场

2002

荷兰皇家壳牌集团收购西门子太阳能、 创建壳牌太阳能

2006

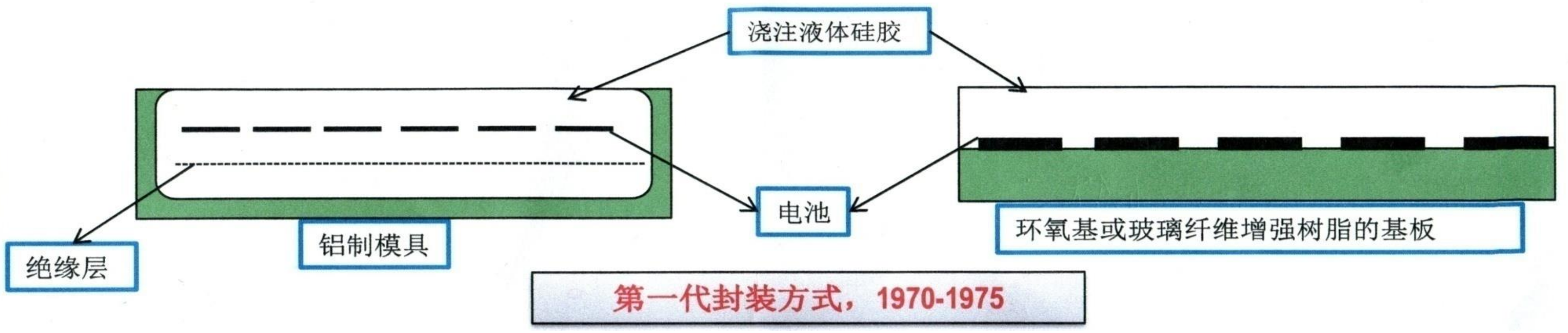
SolarWorld 获得壳牌太阳能

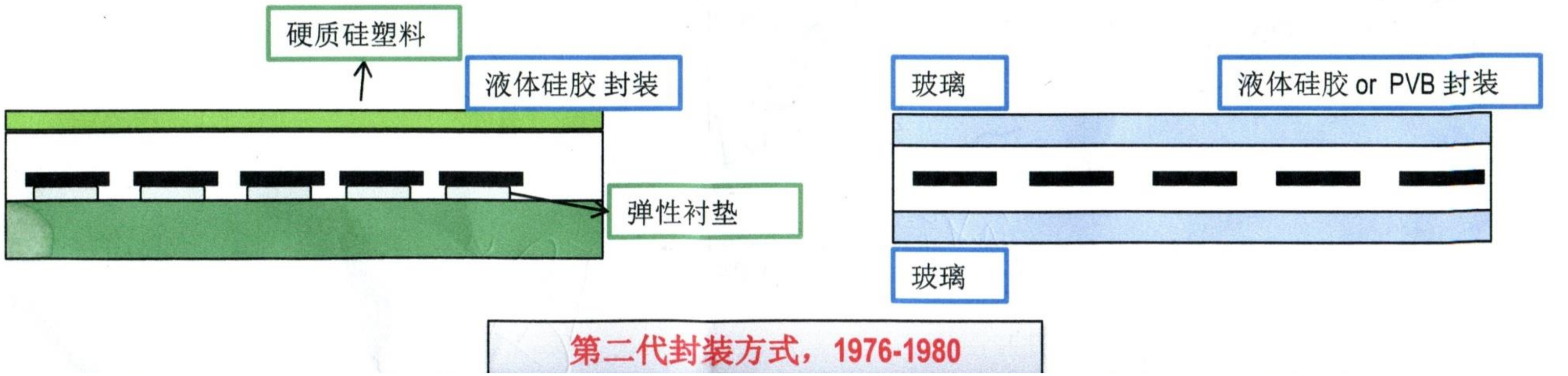
4.绝缘材料是地面太阳能发电的关键

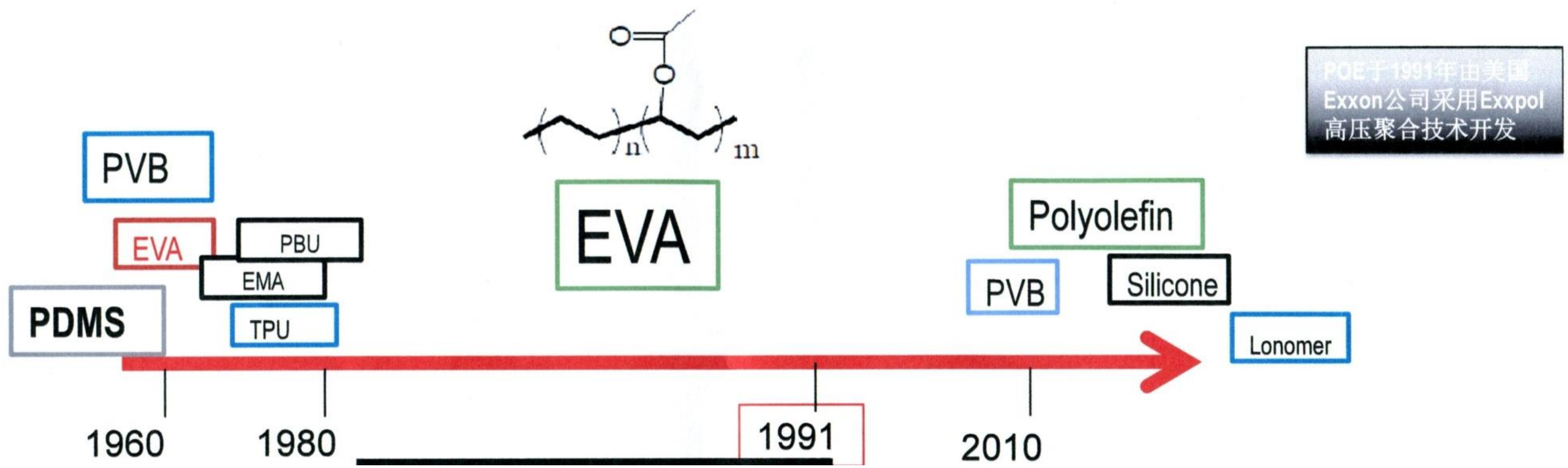
太空与地面的区别在于太空是电子无尘的环境，而地面则有水、氧等的腐蚀和人类的活动，这和电池片转换效率的高低没有关系，没有绝缘材料的保护,电池片无法生存,更别提系统,电站.组件的安全可靠优质长效取决于封装材料的好坏：

1).高透光率
2).高绝缘性
3).长期工作的稳定性

以下为组件发展路线图：







在全球顶尖的高分子化学专家革命性的创造出EVA固化体系，通过设备厂商的配合，从1980年开始得到大规模的应用。长期的实绩证明是1998年组件制造商敢于承诺20年质保的依据。

5.EVA固化体系

作为塑料EVA树脂广泛应用电缆包装鞋材等，但这些均是热塑性及不透明的。光伏用EVA是一种创新性的应用：将VA含量较高的低分子量均聚物用交联剂固化而得到柔韧透明的有一定保护作用的高分子材料。（未固化的EVA颗粒为低熔点树脂，无任何实用价值，只有正确合理的固化才能满足需要）

EVA包封混合物基本配方

技术要求

商品名	生产商	材料作用	每100分用量
Elvax®	Dupont	EVA聚合物共混物	100
Naugard P	Ciba	抗氧剂	
Tinuvin 7709	Ciba	UV稳定剂	
TAC; TAIC	Evonik	交联助剂	
Dynasilan Memo	Evonik	粘结力促进剂	
Curox ® Solar SC [DHBP]	United I.	标准交联过氧化物	1.0 – 2.0
Curox ® Solar FC [TBPEHC]	United I.	快速交联过氧化物	1.0 - 2.5
Curox ® Solar UFC- types	United I.	超快速交联过氧化物	1.0 – 2.5

主要要求：

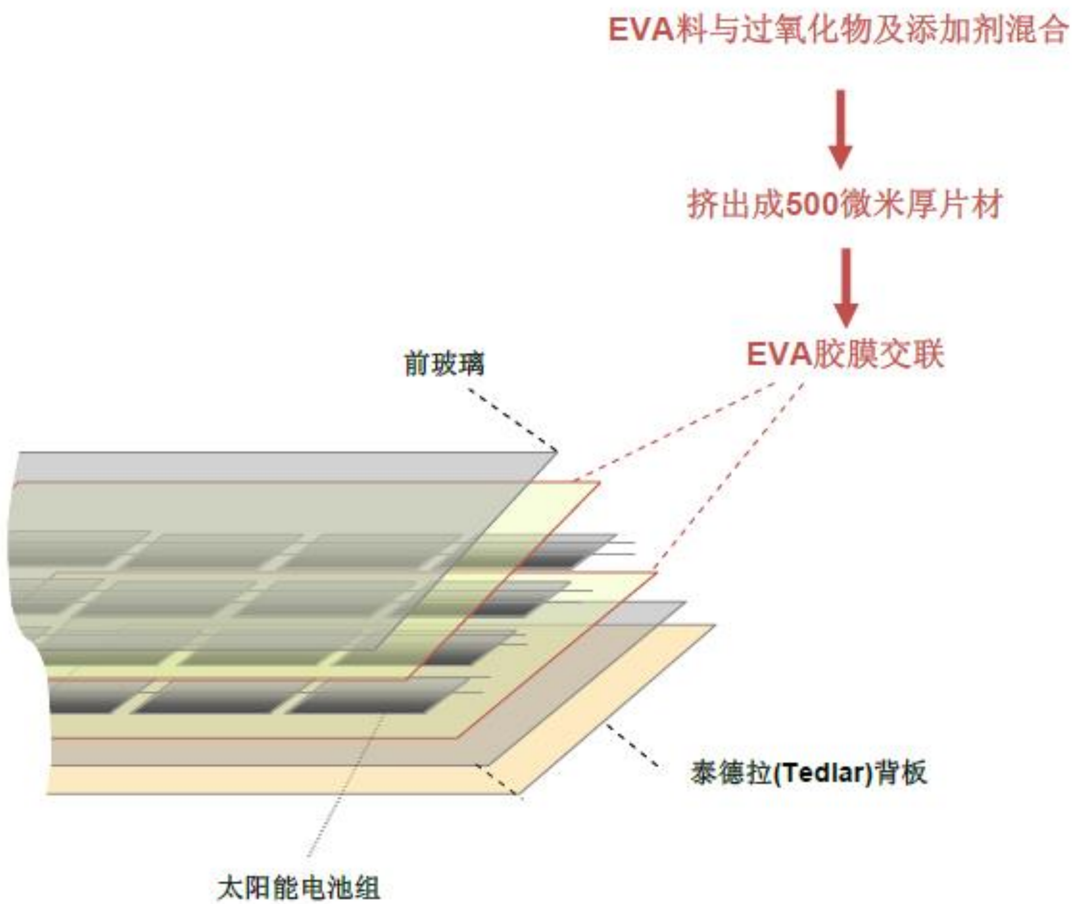
- 透明性 → 高透光率
- 不黄变，UV保护
- 抗水解
- 低收缩和蠕变

→ *确保使用寿命*

> 20 年

光伏加工过程**EVA**交联
太阳能电池板真空层压包封

- 硅砂在**1400**℃以上熔化
- 拉丝（硅杆）
- 切成**0.25-0.4mm**厚片
- 不同原子沉积（气态）
- 硅片连接成组
- 真空包封



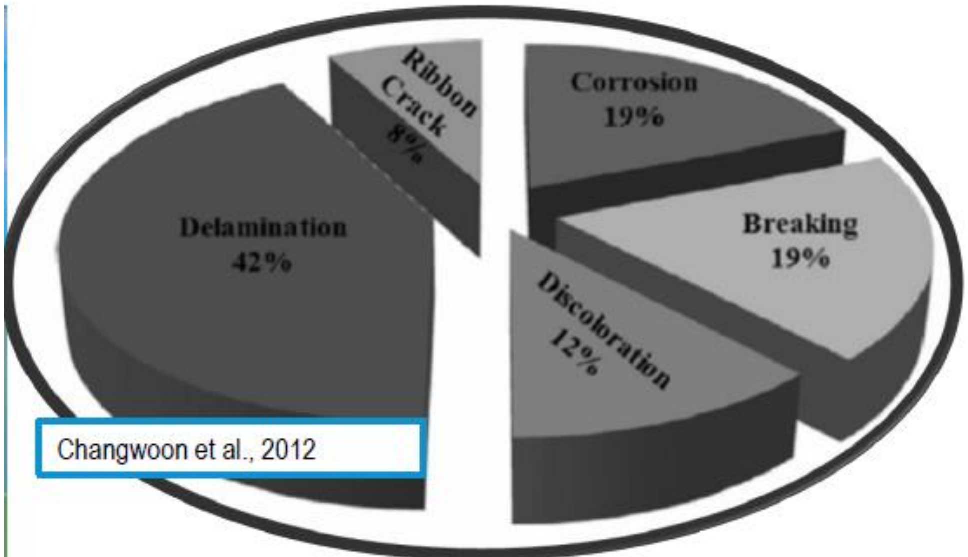
- 安装框架、密封和接线盒

不同EVA的差别

Items			Units	Method	BS	Competitor		
					S11	J	E	U
Type			—	—	Fast	Fast	Ultra Fast	Fast
Cure (155°C)	Gel content (20min)		%	Extraction by xylene	**94**	87	**94**	86
	Time-to-80% gel content		min		8	15	**5**	10
Adhesion (180° peel)	Glass		N/cm	BS method	**30**	19	18	22
	PET		N/cm		**58**	6	11	35
Optical property	Optical transmission (400-1000nm)	Initial	%	JIS K 7361	89.5	89.5	89.5	89.3
		After s-UV 200hrs			**88.5**	87.6	88.3	88.0
		After 85°C 1000hrs			89.5	89.6	89.3	89.1
		After 85°C85%RH 1000hrs			**83.0**	82.8	83.0	82.5
	Yellow index	Initial	-	JIS Z 8722	1.1	1.0	0.9	0.9
		After s-UV 200hrs			**4.1**	6.6	6.1	5.4
		After 85°C 1000hrs			**1.1**	1.2	1.7	1.7
		After 85°C85%RH 1000hrs			**-0.2**	-0.2	2.7	2.3
Volume resistivity(25°C)	1000V applied		logΩ·cm	JIS K6911	**15.0**	14.1	14.2	13.1
Inflation (150°C)	Time-to-inflate		min	BS method	**98**	75	20	10
Handling	Packing with separate film		-	-	**unnecessary**	unnecessary	necessary	necessary
	Roll length : 100-400M(flexibility)		-	-	**Yes**	-	-	No

: ***EVASKY*** advantages

劣质EVA的危害



脱层 42%
变色 12%
腐蚀 19%

73%的失效与封装材料有关

- 1989年，在加利福利亚地区的一个安装仅4年的5WM光伏电站，因为EVA的变色导致30%以上的功率衰减，震动业界。

从2008年开始，深入接触到99%以上的中国EVA胶膜生产厂商，他们大部分由塑料加工业者转型而来，国外只有寥寥几家厂商敢于生产EVA胶膜，而国内最高峰时有300多家，出于对组件厂的担心，不得不努力普及宣传绝缘材料的重要性。我们不仅为直接用户提供技术支持，而且还延伸到终端用户及设备厂商。

Berstorff　BURKLE PROCESS TECHNOLOGIES

我们还参加了一系列的专业学术活动，如

40th IEEE PHOTOVOLTAIC SPECIALISTS CONFERENCE

March 25, 2014

To: Shudong Zhou
General Manager&Senior Engineer of Guangzhou
Botthleader Electrical Materials Co., Ltd.

From: Angele Reinders
Program Chair, 40th IEEE PVSC

Abstract Reference No. 1653

Dear Colleague:

I am pleased to inform you that the Program Committee for the 40th Photovoltaic Specialists Conference has selected your paper entitled "The influence of crosslinking agent on the properties of EVA resin" for an oral presentation at the conference on the basis of its outstanding quality and significance to PV. Congratulations! I would be very grateful if you could advise your co-authors, if any, of this decision.

Your oral presentation is scheduled for the session entitled which will be on at 1409904808. Please refer to the website http://www.ieee-pvsc.org for all conference information and updates.

Your presentation and paper are very important to the conference and to the PV community. **To confirm your participation in the conference, you must click the link below** and follow the instructions on the website **by Monday April 14, 2014.** If you are unable to give your presentation for any reason, please be sure to indicate this at the same link.

http://www.ieee-pvsc.org/confirm.php?a=1653&u=gzbld

Please also be sure register for the conference, which can be done conveniently at the website. The deadline for discounted early registration is May 5th, 2014.

Your talk should be 12 minutes in length, with about 3 additional minutes for questions from the audience. Your presentation slides must be in electronic format – no other form of presentation will be available. You must upload your presentation no later than the day before your presentation. Please be sure to follow the instructions at Author Central > Oral Presenters on the website.

Your complete manuscript and IEEE copyright form must be uploaded onto the website by May 26, 2014. You will not be permitted to present your paper, nor will it be published, unless you have met this requirement. Please follow the manuscript preparation guidelines under Instructions for Authors on the website.

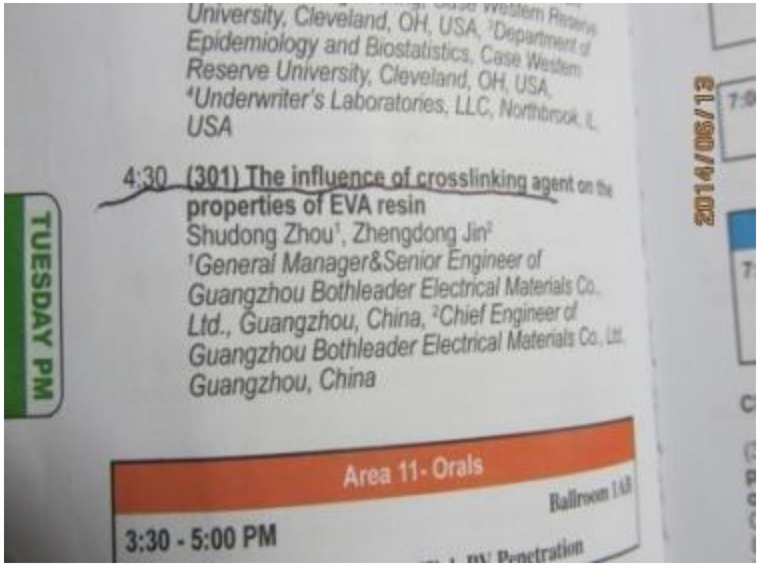
Again, I would like to congratulate you on the high technical quality of your paper and its upgrade to Oral status. I look forward to welcoming you to Denver for the 40th IEEE Photovoltaic Specialists Conference.

Sincerely,

Angele Reinders
Technical Program Chair, 40th IEEE PVSC

Richard King
General Chair, 40th IEEE PVSC

Colorado Convention Center, Denver, CO
June 8-13, 2014
Sponsored by the IEEE Electron Devices Society



TUESDAY PM

University, Cleveland, OH, USA, [3]Department of Epidemiology and Biostatistics, Case Western Reserve University, Cleveland, OH, USA, [4]Underwriter's Laboratories, LLC, Northbrook, IL USA

4:30 (301) The influence of crosslinking agent on the properties of EVA resin

Shudong Zhou[1], Zhengdong Jin[2]

[1]General Manager&Senior Engineer of Guangzhou Bothleader Electrical Materials Co. Ltd., Guangzhou, China, [2]Chief Engineer of Guangzhou Bothleader Electrical Materials Co., Ltd. Guangzhou, China

Area 11- Orals

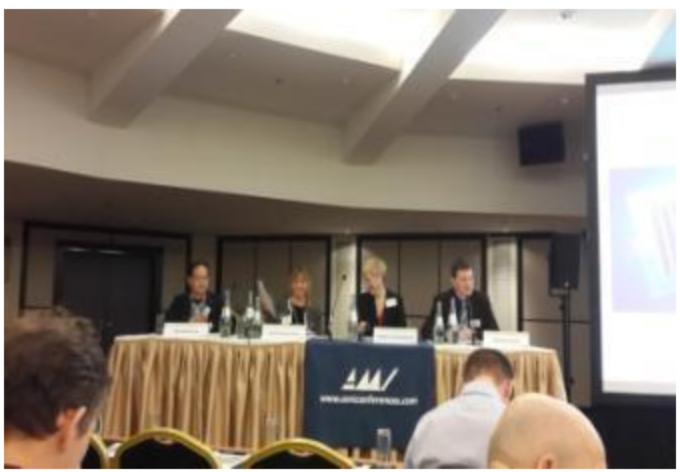
Ballroom 1AB

3:30 - 5:00 PM

IEEE第40届光伏会议主办方为：光子学会，电子元器件学会，电力能源协会，虽然电池片属半导体材料，但组件已属电工设备。我的论文已被收录,由于涉及质量,表征,可靠性,大会主办方特为此开中文同传。UL,NREL,ISE,PI均表达了极大的关注和合作的意向.我们的研究成果处于国际领先.为光伏发展做出了极大贡献，今年我们在德国成立了公司，弗莱恩霍夫研究所及相关协会及企业展开合作。

2015年2月，应邀在德国“聚合物在光伏应用大会”作报告。

In Feb.2015, be invited to report in polymer in photovoltaic application conference in Germany.



IEC TC82光伏能源系统标准化技术委员会是在光伏组件产品得到多年应用后成立的，国内对口单位为半导体材料与设备标委会。组件是电工装备,不是电子元件,半导体材料及生产半导体的设备.

作为中国绝缘材料标委会委员，参与玻璃国标及背板膜国标制订,在国际IEC2013年会上得到高度评价和鼓励.在我们的努力下，封装材料和背板膜已经归口IEC TC15.在我的努力下,从2014年开始,EVA胶Rv提高了一到二个数量级，意味着组件漏电流大幅降低。提高了发电量,延长了组件的生命周期,从整体上全面提升了国内光伏行业的质量.在中国太阳能发电行业创造了巨大的经济效益和社会效益.


结论 Conclusion

光伏其实是非常高科技的产业,覆盖了电子电工的领域,组件是光机电一体化的装备.只有清楚认识到电池与组件，元件与系统，半导体材料与导体，绝缘材料的不同之处，重视器件设计和后端封装工艺，如电连接结构，面板和背板，大面积功率器件的current crowding过载问题,尤其是封装材料和工装,工艺,才能真正做好组件,让光伏产业健康持续发展。

百年大计质量第一，太阳能发电应该是光明的,光彩的,是价值而不是价格的竞争,高效高可靠是提质增效的维一方向,我们愿意与国内光伏企业展开合作，帮你们在激烈的竞争中脱颖而出，为中国制造,选择责任与担当,为更多人能分享阳光.

谨以此文向光伏的先驱致以最高的敬意。(John Bill Yerkes; Dr.Richard M.Swanson; Dr.Martin A.Green，1975,工程师和企业家比尔耶基斯创建国际太阳能技术,solarworld的前身,Dr.Richard M.Swanson,1985,sunpower,IEEE2002; Dr.Martin A.Green,IEEE1990)