



Global Markets, Technologies and Applications for Flexible Displays

August 2017

Kaustubha Parkhi

Report Code: SMC087B

Table of Contents

Chapter 1: Introduction	1
Study Goals and Objectives.....	1
Reasons for Doing This Study.....	2
Scope of Report.....	2
Information Sources.....	3
Methodology.....	3
Geographic Breakdown.....	3
Analyst's Credentials.....	8
Related BCC Research Reports.....	8
Chapter 2: Summary and Highlights	10
Chapter 3: Overview of Flexible Displays	14
Definition	14
Introduction to Display Components.....	14
Present-day Display Technologies	15
CRT.....	15
LCD.....	15
LED.....	16
Plasma	16
Implications of Flexibility	16
Flexible Back-end Materials: The Thin-Film Transistor Story	17
Flexible Batteries	18
Flexible Encapsulation	19
Flexibility in Substrates.....	19
Dynamic Interferometry	20
AMAX Evaporation Printing.....	21
Roll-to-Roll Processing.....	21
Front-end Emission (Display) Technologies	21
Global Market Overview for Shipments.....	21
Organic Light Emitting Diode	22
Introduction.....	22
How It Works.....	23
Suitability for Flexible Displays.....	23
Major OLED Commercialization Announcements.....	23
Electrophoretic Displays	24
Introduction.....	24
How it Works.....	24
Suitability for Flexible Displays.....	25
Electrowetting, ChLCD and OLCD.....	26
Electrowetting Displays	26
ChLCD from Kent Displays Inc.	28
Flexible Organic LCD from FlexEnable.....	28
Printing and Lithography Technologies	28
Global Market Overview	28
Shadow Mask/Vapor Deposition and Other Low-Resolution Technologies	30
Inkjet Printing.....	31
Imprint Lithography.....	32

Photolithography.....	32
Substrate Fabrication Methodologies	32
Global Market Overview	33
Conventional Fabrication	34
Roll-to-Roll and Others.....	34
Breakdown by Region	35
Breakdown by Applications	37
Challenges in Flexible Display Synthesis and Industry Solutions	40
Flexible and Temperature Resistant Substrate	40
Low Yields.....	40
4D Technology PolarCam Micropolarizer for R2R Substrates.....	40
4D Technology FlexCam Optical Surface Profiler Micropolarizer for R2R Substrates	40
NovaCentrix PulseForge: Addressing the Curing Dilemma	41
Chapter 4: Global Market for Flexible Displays in Key Applications	43
E-Book Readers and Tablets	43
Breakdown by Display Technologies.....	43
Breakdown by Printing and Lithography Technologies.....	45
Breakdown by Substrate Fabrication Methodologies.....	47
Breakdown by Region.....	48
Notebooks and Personal Computers	50
Breakdown by Display Technologies	50
Breakdown by Printing and Lithography Technology	51
Breakdown by Substrate Fabrication Methodology	53
Breakdown by Region.....	55
Mobile Phones and Smartphones.....	56
Breakdown by Display Technology.....	56
Breakdown by Printing and Lithography Technology	58
Breakdown by Substrate Fabrication Methodology	60
Breakdown by Region.....	62
Gaming Devices and Media Players	63
Breakdown by Display Technology.....	64
Breakdown by Printing and Lithography Technology	65
Breakdown by Substrate Fabrication Methodology	67
Breakdown by Region.....	69
Automotive and Navigation.....	70
Breakdown by Display Technologies.....	70
Breakdown by Printing and Lithography Technology	72
Breakdown by Substrate Fabrication Methodology	74
Breakdown by Region.....	76
Smart Cards and Other Cards	77
Breakdown by Display Technology.....	78
Breakdown by Printing and Lithography Technology	79
Breakdown by Substrate Fabrication Methodology	81
Breakdown by Region.....	83
Signage and Billboards	84
Breakdown by Display Technologies	85
Breakdown by Printing and Lithography Technology	86
Breakdown by Substrate Fabrication Methodology	88
Breakdown by Region.....	90
Retail and Logistics.....	91

Breakdown by Display Technology.....	92
Breakdown by Printing and Lithography Technologies.....	93
Breakdown by Substrate Fabrication Methodology	95
Breakdown by Regions	97
Wearables and Defense	98
Breakdown by Display Technology.....	99
Breakdown by Printing and Lithography Technology	100
Breakdown by Substrate Fabrication Methodology	102
Breakdown by Region.....	104
Chapter 5: Patent Analysis	107
Trends by Functional Categories.....	107
Trends by Year	116
Trends by Country.....	117
Trends by Assignee	118
Chapter 6: Analysis of Market Opportunities	129
Challenges and Display Technologies	129
Stakeholder Approach to Problem Solving.....	129
End-Application Dynamics and Market Opportunity.....	131
E-Book Readers and Tablets.....	131
Notebooks and PCs.....	131
Mobile Phones and Smartphones	131
Gaming Devices and Media Players	132
Automotive and Navigation	132
Smart Cards and Other Cards.....	132
Signage and Billboards	133
Retail and Logistics	133
Wearables and Defense	133
Chapter 7: Company Profiles	135
Longevity Dilemma	135
Delaying Factors	135
Hope Ahead	136
Stakeholder Categories.....	136
Display Makers	137
OEMs	137
Back-end Flexibility Specialists	137
Front-End Emission Specialists.....	138
Flexible Battery Developers	138
Research Institutions.....	138
Substrate and Encapsulation Specialists	138
Glass Manufacturers	139
Equipment and Process Experts.....	139
Company Profiles	139
About BCC Research.....	179
About BCC Research.....	180
BCC Membership	180
BCC Custom Research	180

List of Tables

Summary Table Global Market for Flexible Displays, by Technology, Through 2022 (\$ Millions)	10
Table 1 Shipments of Flexible Displays, by Display Technology, Through 2022 (Millions of Units)	22
Table 2 Global Market for Flexible Displays, by Printing and Lithography Technology Type, Through 2022 (\$ Millions)	29
Table 3 Shipments of Flexible Displays, by Printing and Lithography Technology Type, Through 2022 (Millions of Units).....	30
Table 4 Global Market for Flexible Displays, by Substrate Fabrication Methodology Type, Through 2022 (\$ Millions)	33
Table 5 Shipments of Flexible Displays, by Substrate Fabrication Methodology Type, Through 2022 (Millions of Units).....	34
Table 6 Global Market for Flexible Displays, by Region, Through 2022 (\$ Millions)	36
Table 7 Shipments of Flexible Displays, by Region, Through 2022 (Millions of Units)	36
Table 8 Global Market for Flexible Displays, by Application, Through 2022 (\$ Millions)	37
Table 9 Shipments of Flexible Displays, by Application, Through 2022 (Millions of Units).....	38
Table 10 Global Market for Flexible Displays Employed in E-Book Reader and Tablet Applications, by Display Technology Type, Through 2022 (\$ Millions)	44
Table 11 Shipments of Flexible Displays Employed in E-Book Reader and Tablet Applications, by Display Technology Type, Through 2022 (Millions of Units).....	44
Table 12 Global Market for Flexible Displays Employed in E-Book Reader and Tablet Applications, by Printing and Lithography Technology Type, Through 2022 (\$ Millions).....	45
Table 13 Shipments of Flexible Displays Employed in E-Book Reader and Tablet Applications, by Printing and Lithography Technology Type, Through 2022 (Millions of Units).....	46
Table 14 Global Market for Flexible Displays Employed in E-Book Reader and Tablet Applications, by Substrate Fabrication Methodology Type, Through 2022 (\$ Millions).....	47
Table 15 Shipments of Flexible Displays Employed in E-Book Reader and Tablet Applications, by Substrate Fabrication Methodology Type, Through 2022 (Millions of Units)	48
Table 16 Global Market for Flexible Displays Employed in E-Book Reader and Tablet Applications, by Region, Through 2022 (\$ Millions).....	49
Table 17 Shipments of Flexible Displays Employed in E-Book Reader and Tablet Applications, by Region, Through 2022 (Millions of Units)	49
Table 18 Global Market for Flexible Displays Employed in Notebook and PC Applications, by Display Technology Type, Through 2022 (\$ Millions).....	50
Table 19 Shipments of Flexible Displays Employed in Notebook and PC Applications, by Display Technology Type, Through 2022 (Millions of Units).....	51
Table 20 Global Market for Flexible Displays Employed in Notebook and PC Applications, by Printing and Lithography Technology Type, Through 2022 (\$ Millions)	52
Table 21 Shipments of Flexible Displays Employed in Notebook and PC Applications, by Printing and Lithography Technology Type, Through 2022 Millions of Units).....	53
Table 22 Global Market for Flexible Displays Employed in Notebook and PC Applications, by Substrate Fabrication Methodology Type, Through 2022 (\$ Millions)	54
Table 23 Shipments of Flexible Displays Employed in Notebook and PC Applications, by Substrate Fabrication Methodology Type, Through 2022 Millions of Units).....	54
Table 24 Global Market for Flexible Displays Employed in Notebook and PC Applications, by Region, Through 2022 (\$ Millions).....	55
Table 25 Shipments of Flexible Displays Employed in Notebook and PC Applications, by Geographical Region, Through 2022 (Millions of Units)	56

Table 26 Global Market for Flexible Displays Employed in Mobile Phone and Smartphone Applications, by Display Technology Type, Through 2022 (\$ Millions)	57
Table 27 Shipments of Flexible Displays Employed in Mobile Phone and Smartphone Applications, by Display Technology Type, Through 2022 (Millions of Units)	58
Table 28 Global Market for Flexible Displays Employed in Mobile Phone and Smartphone Applications, by Printing and Lithography Technology Type, Through 2022 (\$ Millions)	59
Table 29 Shipments of Flexible Displays Employed in Mobile Phone and Smartphone Applications, by Printing and Lithography Technology Type, Through 2022 (Millions of Units)	60
Table 30 Global Market for Flexible Displays Employed in Mobile Phone and Smartphone Applications, by Substrate Fabrication Methodology Type, Through 2022 (\$ Millions)	61
Table 31 Shipments of Flexible Displays Employed in Mobile Phone and Smartphone Applications, by Substrate Fabrication Methodology Type, Through 2022 (Millions of Units)	61
Table 32 Global Market for Flexible Displays Employed in Mobile Phone and Smartphone Applications, by Region, Through 2022 (\$ Millions)	62
Table 33 Shipments of Flexible Displays Employed in Mobile Phone and Smartphone Applications, by Region, Through 2022 (Millions of Units)	63
Table 34 Global Market for Flexible Displays Employed in Gaming Devices and Media Player Applications, by Display Technology Type, Through 2022 (\$ Millions)	64
Table 35 Shipments of Flexible Displays Employed in Gaming Devices and Media Player Applications, by Display Technology Type, Through 2022 (Millions of Units)	65
Table 36 Global Market for Flexible Displays Employed in Gaming Devices and Media Player Applications, by Printing and Lithography Technology Type, Through 2022 (\$ Millions)	66
Table 37 Shipments of Flexible Displays Employed in Gaming Devices and Media Player Applications, by Printing and Lithography Technology Type, Through 2022 (Millions of Units)	67
Table 38 Global Market for Flexible Displays Employed in Gaming Devices and Media Player Applications, by Substrate Fabrication Methodology Type, Through 2022 (\$ Millions)	68
Table 39 Shipments of Flexible Displays Employed in Gaming Devices and Media Player Applications, by Substrate Fabrication Methodology Type, Through 2022 (Millions of Units)	68
Table 40 Global Market for Flexible Displays Employed in Gaming Devices and Media Player Applications, by Region, Through 2022 (\$ Millions)	69
Table 41 Shipments of Flexible Displays Employed in Gaming Devices and Media Player Applications, by Region, Through 2022 (Millions of Units)	70
Table 42 Global Market for Flexible Displays Employed in Automotive and Navigation Applications, by Display Technology Type, Through 2022 (\$ Millions)	71
Table 43 Shipments of Flexible Displays Employed in Automotive and Navigation Applications, by Display Technology Type, Through 2022 (Millions of Units)	72
Table 44 Global Market for Flexible Displays Employed in Automotive and Navigation Applications, by Printing and Lithography Technology Type, Through 2022 (\$ Millions)	73
Table 45 Shipments of Flexible Displays Employed in Automotive and Navigation Applications, by Printing and Lithography Technology Type, Through 2022 (Millions of Units)	74
Table 46 Global Market for Flexible Displays Employed in Automotive and Navigation Applications, by Substrate Fabrication Methodology Type, Through 2022 (\$ Millions)	75
Table 47 Shipments of Flexible Displays Employed in Automotive and Navigation Applications, by Substrate Fabrication Methodology Type, Through 2022 (Millions of Units)	75
Table 48 Global Market for Flexible Displays Employed in Automotive and Navigation Applications, by Region, Through 2022 (\$ Millions)	76
Table 49 Shipments of Flexible Displays Employed in Automotive and Navigation Applications, by Region, Through 2022 (Millions of Units)	77
Table 50 Global Market for Flexible Displays Employed in Smart Card and Other Card Applications, by Display Technology Type, Through 2022 (\$ Millions)	78

Table 51 Shipments of Flexible Displays Employed in Smart Card and Other Card Applications, by Display Technology Type, Through 2022 (Millions of Units).....	79
Table 52 Global Market for Flexible Displays Employed in Smart Card and Other Card Applications, by Printing and Lithography Technology Type, Through 2022 (\$ Millions).....	80
Table 53 Shipments of Flexible Displays Employed in Smart Card and Other Card Applications, by Printing and Lithography Technology Type, Through 2022 (Millions of Units).....	81
Table 54 Global Market for Flexible Displays Employed in Smart Card and Other Card Applications, by Substrate Fabrication Methodology Type, Through 2022 (\$ Millions).....	82
Table 55 Shipments of Flexible Displays Employed in Smart Card and Other Card Applications, by Substrate Fabrication Methodology Type, Through 2022 (Millions of Units).....	82
Table 56 Global Market for Flexible Displays Employed in Smart Card and Other Card Applications, by Region, Through 2022 (\$ Millions).....	83
Table 57 Shipments of Flexible Displays Employed in Smart Card and Other Card Applications, by Region, Through 2022 (Millions of Units).....	84
Table 58 Global Market for Flexible Displays Employed in Signage and Billboard Applications, by Display Technology Type, Through 2022 (\$ Millions).....	85
Table 59 Shipments of Flexible Displays Employed in Signage and Billboard Applications, by Display Technology Type, Through 2022 (Millions of Units).....	86
Table 60 Global Market for Flexible Displays Employed in Signage and Billboard Applications, by Printing and Lithography Technology Type, Through 2022 (\$ Millions).....	87
Table 61 Shipments of Flexible Displays Employed in Signage and Billboard Applications, by Printing and Lithography Technology Type, Through 2022 (Millions of Units).....	88
Table 62 Global Market for Flexible Displays Employed in Signage and Billboard Applications, by Substrate Fabrication Methodology Type, Through 2022 (\$ Millions).....	89
Table 63 Shipments of Flexible Displays Employed in Signage and Billboard Applications, by Substrate Fabrication Methodology Type, Through 2022 (Millions of Units).....	89
Table 64 Global Market for Flexible Displays Employed in Signage and Billboard Applications, by Region, Through 2022 (\$ Millions).....	90
Table 65 Shipments of Flexible Displays Employed in Signage and Billboard Applications, by Region, Through 2022 (Millions of Units).....	91
Table 66 Global Market for Flexible Displays Employed in Retail and Logistics Applications, by Display Technology Type, Through 2022 (\$ Millions).....	92
Table 67 Shipments of Flexible Displays Employed in Retail and Logistics Applications, by Display Technology Type, Through 2022 (Millions of Units).....	93
Table 68 Global Market for Flexible Displays Employed in Retail and Logistics Applications, by Printing and Lithography Technology Type, Through 2022 (\$ Millions).....	94
Table 69 Shipments of Flexible Displays Employed in Retail and Logistics Applications, by Printing and Lithography Technology Type, Through 2022 (Millions of Units).....	95
Table 70 Global Market for Flexible Displays Employed in Retail and Logistics Applications, by Substrate Fabrication Methodology Type, Through 2022 (\$ Millions).....	96
Table 71 Shipments of Flexible Displays Employed in Retail and Logistics Applications, by Substrate Fabrication Methodology Type, Through 2022 (Millions of Units).....	96
Table 72 Global Market for Flexible Displays Employed in Retail and Logistics Applications, by Region, Through 2022 (\$ Millions).....	97
Table 73 Shipments of Flexible Displays Employed in Retail and Logistics Applications, by Region, Through 2022 (Millions of Units).....	98
Table 74 Global Market for Flexible Displays Employed in Wearables and Defense Applications, by Display Technology Type, Through 2022 (\$ Millions).....	99
Table 75 Shipments of Flexible Displays Employed in Wearables and Defense Applications, by Display Technology Type, Through 2022 (Millions of Units).....	100

Table 76 Global Market for Flexible Displays Employed in Wearables and Defense Applications, by Printing and Lithography Technology Type, Through 2022 (\$ Millions).....	101
Table 77 Shipments of Flexible Displays Employed in Wearables and Defense Applications, by Printing and Lithography Technology Type, Through 2022 (Millions of Units).....	102
Table 78 Global Market for Flexible Displays Employed in Wearables and Defense Applications, by Substrate Fabrication Methodology Type, Through 2022 (\$ Millions).....	103
Table 79 Shipments of Flexible Displays Employed in Wearables and Defense Applications, by Substrate Fabrication Methodology Type, Through 2022 (Millions of Units).....	103
Table 80 Global Market for Flexible Displays Employed in Wearables and Defense Applications, by Region, Through 2022 (\$ Millions).....	104
Table 81 Shipments of Flexible Displays Employed in Wearables and Defense Applications, by Region, Through 2022 (Millions of Units).....	105
Table 82 U.S. Patents in Flexible Displays, by Patent Category, 1976–April 2017.....	115
Table 83 U.S. Patents in Flexible Displays, by Grant Year, 1976–April 2017.....	116
Table 84 U.S. Patents in Flexible Displays, by Grant Year, 1976–April 2017.....	117
Table 85 Assignees for U.S. Patents in Flexible Displays, 1976–April 2017.....	118
Table 86 Assignees of Four or More U.S. Patents in Flexible Displays, 1976–April 2017.....	121

List of Figures

Summary Figure Global Market for Flexible Displays, by Technology, 2016–2022 (\$ Millions)..... 11



About BCC Research

About BCC Research

With our unparalleled 45-year history, BCC Research provides comprehensive analysis of global market sizing, forecasting and industry intelligence, covering markets where advances in science and technology are improving the quality, standard and sustainability of businesses, economies and lives.

BCC Membership

From market sizing and forecasts, to opportunity assessments and competitive analyses, our ever-expanding library gives you the data, insights and intelligence required to ensure your project is a success. Members benefit from ongoing, unlimited access to the category or collections of their choice, and most membership packages pay for themselves within two to three reports being accessed.

Did you buy this report? You may qualify to apply your purchase price toward a full membership. Call 866/285-7215 or e-mail info@bccresearch.com to request a demo.

BCC Custom Research

Our experts provide custom research projects to those working to identify new markets, introduce new products, validate existing market share, analyze competition and assess the potential for products to impact existing markets. With impressive academic credentials and broad and deep knowledge of global industrial markets, our independent analysts and consultants develop the facts, figures, analysis and assessments to inform the decisions that will move your company ahead. Confidential inquiries to: custom@bccresearch.com or 781-205-2429.

DISCLAIMER

The information developed in this report is intended to be as reliable as possible at the time of publication and is of a professional nature. This information does not constitute managerial, legal or accounting advice, nor should it be considered as a corporate policy guide, laboratory manual or an endorsement of any product, as much of the information is speculative in nature. BCC Research and the author assume no responsibility for any loss or damage that might result from reliance on the reported information or from its use.

ISBN: 1-62296-533-7
August 2017