71st International Cable and Connectivity Symposium (IWCS 2022)

Rebooting the Future of our Industry and Communities

Providence, Rhode Island, USA 10 - 13 October 2022

ISBN: 978-1-7138-7432-4

Printed from e-media with permission by:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright $\ \, \ \, \ \,$ (2022) by International Wire and Cable Symposium (IWCS) All rights reserved.

Printed with permission by Curran Associates, Inc. (2023)

For permission requests, please contact International Wire and Cable Symposium (IWCS) at the address below.

International Wire and Cable Symposium (IWCS) 644 Shrewsbury Commons Ave.
PMB #250
Shrewsbury, PA 17361
USA

Phone: +1 717 993 9500

www.iwcs.org

Additional copies of this publication are available from:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571 USA Phone: 845-758-0400

Fax: 845-758-2633

Email: curran@proceedings.com Web: www.proceedings.com

TABLE OF CONTENTS

SESSION 1: Executive Session

- 1-1 Global Transition in Metals Markets 2
- 1-2 The Five-Year Outlook for Fiber and Deployment 3
- 1-3 Global Economic Outlook 4
- 1-4 Power Cable Systems Enabling the Energy Transition 5
- 1-5 What can 5G deliver? A Faster Horse?" 6

Plenary Luncheon

Keynote Presentation: **Technology Drivers for Deployment and Full Potential Utilization of 5G;** Andrea Caldini, *VP of Product Engineering & Technology, Verizon, USA*

Panel Discussions

Women in Cable & Connectivity 10

Young Professionals & Early Career 16

Supplier Spotlight Session

SESSION 2: Materials

- 2-1 Thermal Aging Challenges for Power-over-Ethernet Cables with PVC Jackets 22
- 2-2 HFFR Cable Compounds: Influence of Flame-Retardant Filler and Coupling Agent on EVA/LLDPE Blend Systems 43
- 2-3 Make High Quality HFFR Wire and Cable Compound on Continuous Mixer 51
- $\begin{array}{lll} \hbox{2--4 How Surface-Treated ATH Can Improve the Overall} \\ \hbox{Performance of HFFR Compounds} & 56 \end{array}$
- 2-5: A Sustainable Approach for Polyethylene Cable Jacket Compounds 64
- 2-6 PEKK A High Performance Thermoplastic for Wire Insulation 71
- 2-7 Optical Fiber Coatings with Improved Tear Strength and Superior Microbending Resistance while Maintaining Robust Draw Processing Capability 75
- 2-8 Development of LED Inks for Optical Fiber Application 80

SESSION 3: Advances in Optical Connectivity

- 3-1 Development of Best Practices and Guidelines for the Use of Expanded Beam Connectors in Data Center Applications 86
- 3-2 A Novel Angled Fiber-Optic Adaptor for APC Connector Inspection 101
- 3-3 Development of 16F, Low-Loss, IEC-Grade B, MMC High-Density Optical Connector and Corresponding Cleaning Tool 105
- 3-4 Accelerated Lifetime Study of 12-Channel Compact Free Space DWDM Components 111
- 3-5 Ferrule Endface Dimension Optimization for Standard Outer Diameter 4-Core Fiber Connector 116
- 3-6 Modeled Connector Loss in Bend Optimized Multimode Fiber Links 122
- 3-7 Reducing Costs and Environmental Impact of Data Center Interconnects with Novel Pre-Terminated High-Fiber Density Cable 131

SESSION 4: Special Applications - Optical Fiber

- 4-1 Fiber Optics in Automotive Applications Take 2 140
- 4-2 Multi-Core Fiber Cable Development 147
- 4-3 Control Using Power-over-Fiber for Remote-Operated Optical Fiber Switching Nodes 150
- 4-4 Impact of Jacket Configuration on Temperature Sensing Performance of Optical Fiber Cables 155

SESSION 5: WOMEN IN CABLE & CONNECTIVITY WITH PANEL DISCUSSION

- 5-1 The Impact of the Electro-Mobility Boom On the Automotive Supply Chain 166
- 5-2 Laser Printing Materials for Wire & Cable Applications: A Technology Overview 174
- 5-3 High Speed Linear Interface Multimode Transmission 178

SESSION 6: Cable Design

- 6-1 SDM Submarine Cable with 200µm Diameter Optical Fiber 186
- 6-2 Self-Supporting Flexible Ribbon Optical Cables A Solution for the Brazilian Market 189
- 6-3 Reduced Size Pre-Terminated Cables for Outside Plant 195
- 6-4 Impact of Jacket Material on Performance of Flexible Ribbon Microduct Cables for FTTx Applications 200
- 6-5 432-Fiber Flexible Ribbon MicroDuct Cable With Enhanced Stiffness for Better Blowing Installation 205

SESSION 7: Fiber Cable Manufacturing

- 7-1 Artificial Intelligence Based Line Control and Predictive Maintenance Increases Productivity 216
- 7-2 Inline Surface Dimensional Flaw Detection and OD/Ovality Measurements with Laser Line Triangulation 225
- 7-3 Low-Bend FRP Rod for FTTH Cables 232

SESSION 8: Optical Fiber Reliability

- 8-1 Wavelengths Analysis of Single Fiber Attenuation and True Splice Losses in 30 Year-Old Cables 240
- 8-2 Microbend Performance and Puncture Load Resistance of Reduced-Clad Fibers 246

POSTER SESSION

- Optical Accurate Diameter Measurement 438
- Development of Anti-Hacking Optical Cable 441
- A New Carbon Black for High Voltage Power Cable Application 446

SESSION 9: Installation & Tools

- 9-1 Cable Blowing 35-Year Historical Review 254
- 9-2 Significance of Common LSZH Formulation Components on Coefficient of Friction 262
- 9-3 Thin Film Drop Cable Bundle for Micro-Trench Installation 271
- 9-4 Applicable Distance in Fiber Termination Identification Using Local Injection and OTDR 276
- 9-5 Development of a Wedge Clamp with a Cable-Cutting Safety Feature ~282

SESSION 10: Codes & Standards

- 10-1 Revisions To UL Certification Requirements Uncoiling Any Confusion! 294
- 10-2 Cabling For Fault Managed Power Systems Class 4 297
- 10-3 The Hidden Risks Associated with Self-Declared Plenum and Riser Cables $\ 300$
- 10-4 Impact of Modifications in External Air-Supply on EN 50399 Cable-Burn Test 303
- 10-5 Guidelines for the Use of Balanced Single-Pair Implementations Within a Balanced 4-Pair Cabling System 309
- 10-6 Influence of Measurement Method on Shrinkback of FRNC Cables 319

SESSION 11: High Density Cable

- 11-1 New Ultra-High-Density UHFC Cable for Easy Installation 326
- 11-2 6,912-Fiber Cable using 160 μ m Coating Optical Fiber with 80 μ m Cladding $_{332}$
- 11-3 Development of High-Density Optical Fiber Cable Using Cutoff-Shifted Fiber 338
- 11-4 High-Density Optical Fiber Cable Using G.654E Fiber 347
- 11-5 Macrobend and Microbend Loss Contributions to Attenuation of High Density Optical Fiber Cables $\ \ \, _{360}$

SESSION 12: Copper Cable

- 12-1 Production Testing of Single-Pair Ethernet Wiring in Cable Harness 366
- 12-2 Shielded Pair Differential Cabling Phase Matters 371
- 12-3 Single-Ended Testing of Coupling Attenuation 381
- 12-4 EMC of Single-Pair Ethernet Cables, Connectors and Assemblies 385
- 12-5 Mixing Segment Specifications for 10 Mb/s Single Pair Multidrop Enhancements 393
- 12-6 Efficacy of Noise Mitigation Strategies Against Packet-in-Packet Cybersecurity Attacks 399

SESSION 13: Multimode Fiber and Data Center

- 13-1 Impact of Optical Return Loss for 400 GBase-SR8 Channels 406
- 13-2 A Perspective For Future MMF Channels Beyond 400 Gbps 411
- 13-3 Multimode Fiber Links for 800 Gb/s and 1.6 Tb/s Networks 417
- $\begin{array}{ll} 13\text{--}4 \text{ Multimode Fiber Solution Empowers Data Centers for Sustainable} \\ \text{High-Speed Operation} & 433 \end{array}$

CANCELLED PRESENTATIONS

- Carbon Black Performance in Virgin and Recycled Polyethylene Sheath Material 450
- Study on Fire Resistance of All Dielectric Optical Cable 454
- Prediction of Ice Thickness of Optical Fiber Composite Overhead Ground Wire (OPGW) Based on Multi-Class Support Vector Machine 458
- Effect of Freezing on Dry High Fiber Density Ultra-Large-Count Bulk Fiber Optic Ribbon Cable 460
- Analysis, Detection and Prevention of Fungus Growth on Optical Cable 465
- Research on Shrinkage Performance of Loose Tube Optical Cable 470
- Tensile Strength of Bare Optical Fibers Based on Indoor Cable Application Scenarios 475
- Study on New Design, Material and Application of Bow-Type Drop Cable 480