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Photonic Textiles for Fashion

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Descriptor (300 words)

Polymeric Optical Fibres (POFs) and textile based yarns are integrated with sensors and remotes to transform conventionally passive fabrics into interactive platforms. This work proposes a research agenda derived from interdisciplinary process that synergizes fashion design and technology.

Early research on POF textiles was primarily skewed towards a technological perspective that investigated the light emitting qualities of the material for the purpose of display panels and light therapy. Tan's research, based on studies of materials, laser surface treatments, component integration, and pattern cutting, demonstrates new methods for fashion design with POFs. The research methods and visual outcomes are original. New developments were made in the areas of material illumination, interactivity, and technology integration into interactive clothing via interdisciplinary methods.

There are many applications in interactive clothing as shown by invited designs for the Hong Kong Museum of History in 2013, and the Hong Kong Heritage Museum in 2016, for new interpretations of traditional Chinese clothing. Related work included a book chapter in Tao (ed.) 'Handbook of Smart Textiles' (2015), a journal publication, an excellent paper award at the 2016 International Conference of the Korean Society of Fashion Business, invitations to solo exhibitions and public lectures at Shih Chien University, Taiwan (2014) and Burapha University, Thailand (2015), invited catwalk showcases at Hong Kong Week, Taiwan, and Shishi Fashion Week in China (2018), an international juried exhibition at the Bangkok Gallery, Thailand (2013), and the successful competitive bidding of 1 PhD student for project sustainability. The outputs received international and local media coverage.

This research achieved control over illumination stability, interactivity and component integration within the context of smart clothing. The research process involved extensive experiments, sampling, and interdisciplinary research with engineers for component and software application designs over a period of six years.

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Jeanne Tan

Jeanne is a textiles and fashion designer. Her practice informs her research and vice versa. Her work investigates the interface of design and technology; integrating traditional craft and engineering as the syntax of the creation's narrative. Jeanne's research focuses on interactive textile design, hybrid design approaches and smart wearables.

Research Questions

This practice based research sets out to investigate:

- How does the integration of sensors and remote controls enable passive textiles and clothing into interactive platforms.
- How POF surface treatment via laser engraving, light source connection via novel couplers and compact power sources can enable even lateral illumination of the POF textiles.
- How an interdisciplinary approach that integrates fashion design, pattern cutting and technology can enable seamless component placement for interactive clothing.

What constitutes the research output/ body of work

4 original interactive fashion entitled:

- Urban Glow Collection (2 dresses) Totem
- (1 dress)
- Lucid Illumination (1 childrenswear outfit)

Book Chapter

- Tan, J. (2015) Photonic Fabrics for Fashion and Interiors. In Tao, X.M.(Ed.) Handbook of Smart Textiles. (1005-1033) New York: Springer. DOI: http://dx.doi.org/10.1007%2F978-981-4451-45-1_29

1 Journal

- Bai, V., Tan, J., Chen, A. and Ge, L. (2019), "Enhancing the wearability and accessibility of illuminated POF garment", International Journal of Clothing Science and Technology, Vol. ahead-of-print No. ahead-of-print. DOI: <https://doi.org/10.1108/IJCST-03-2019-0028>

2 Conference papers

- Tan, J.(2016) Photonic Patterns: Fashion cutting with illuminating polymeric optical fibre textiles presented at The Second International Conference for Creative Pattern Cutting. University of Huddersfield. 24-25 February 2016. <https://core.ac.uk/download/pdf/61217121.pdf>
- Tan, J., Wong, W.C., Bai, B.Z. and Ge, L. (2016) The challenges of wearable technology from a polymer optical fibre (POFs) textile perspective presented at The New Paradigm of Global Fashion Business in ICT Convergence 2016 International Conference. Soongsil University, Seoul, South Korea. 29 October 2016.

Tan's contribution to research are:

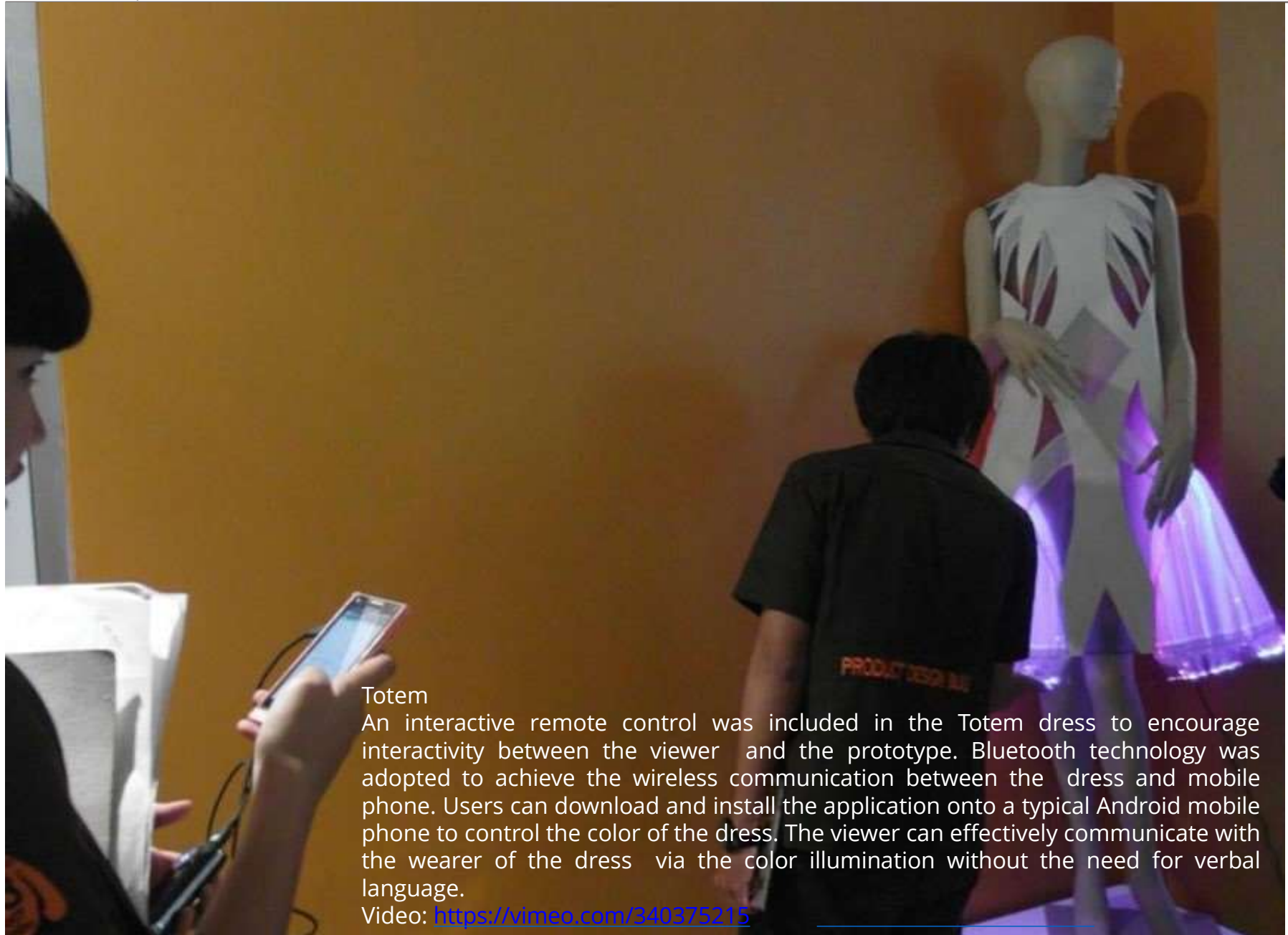
- The production or original interactive fashion designs with POF textiles as medium
- Integrated sensors and remote controls for illuminative fashion designs.
- Novel production methods to overcome fragile characteristics of POFs.
- Expand possibilities for POF textile application in wearables.



Urban Glow

Inspired by the elegant movements by ladies wearing traditional cheongsams, a gyro sensor was selected for the Urban Glow collection. Gyro sensors are devices that sense angular velocity. In this research, a gyro sensor was embedded in the motherboard to detect the motion of the wearer's body. The colors of the LEDs were predetermined according to the changing angle of the gyro sensor. Therefore, the color of the garment changes as the wearer moves. The wearer can actively change and control the emitted colors of the garment by simply changing her movements.

Video: <https://vimeo.com/318156183>



Totem

An interactive remote control was included in the Totem dress to encourage interactivity between the viewer and the prototype. Bluetooth technology was adopted to achieve the wireless communication between the dress and mobile phone. Users can download and install the application onto a typical Android mobile phone to control the color of the dress. The viewer can effectively communicate with the wearer of the dress via the color illumination without the need for verbal language.

Video: <https://vimeo.com/340375215>



Lucid Illumination

POF textiles are reliant on the woven fibers to transmit light and thus conventional cut and sew methods are irrelevant to the construction process. The fiber lengths had to be kept intact to ensure light transmission. The design, pattern cutting and components had to be considered in tandem to ensure a cohesive design.

Research Field and Key Works Referenced

Using POF as the medium, Tan's research employs an interdisciplinary practice based approach to explore the integration of technology to transform passive textiles into interactive lucent platforms. Existing relevant research were technologically focused on POF as flexible displays and illuminating fashion with applied surface materials. Koncar's (2005) research on POF textiles led to small rigid POF screens on a jacket while micro-LEDs, electro-luminescent wires and LED yarns had been applied onto illuminative clothing by companies such as Cute Circuit's Galaxy Dress (2013), Enlighted's performance costume for Britney Spears(2010) and PEGA's cycling jacket (2011). Such designs are reliant on the base textile as a canvas and applying the illuminative component as surface embellishments. POF textiles possess the familiar tactility of conventional textiles.

Although there is an increasing amount of research which explores wearable technology from the designer's and craftsman's perspectives (Buechley, 2013; Hartman, 2014 & Buechley & Perner-Wilson, 2013), their approach tends to utilize the textile as a canvas and the technology as a form of surface embellishments. Such research insights are important for creating increasing awareness and acceptance of smart products. However, the design process and considerations of applying technology to textiles are very different to those of POF textiles and products. POF textiles' technology and material are integral to the product design and are not used as a separate function. Therefore the design and technological considerations need to be considered in tandem starting from the selection of the yarns, as each variation will have direct impact on both aesthetics and functions.

This body of research served to show insights into the integral design process for hybrid products and investigate original methods and techniques for even illumination, sensor and remote integration, POF coupling, garment construction and pattern cutting. The research was conducted via systematic design practice comprising of extensive tests, experiments and developments.

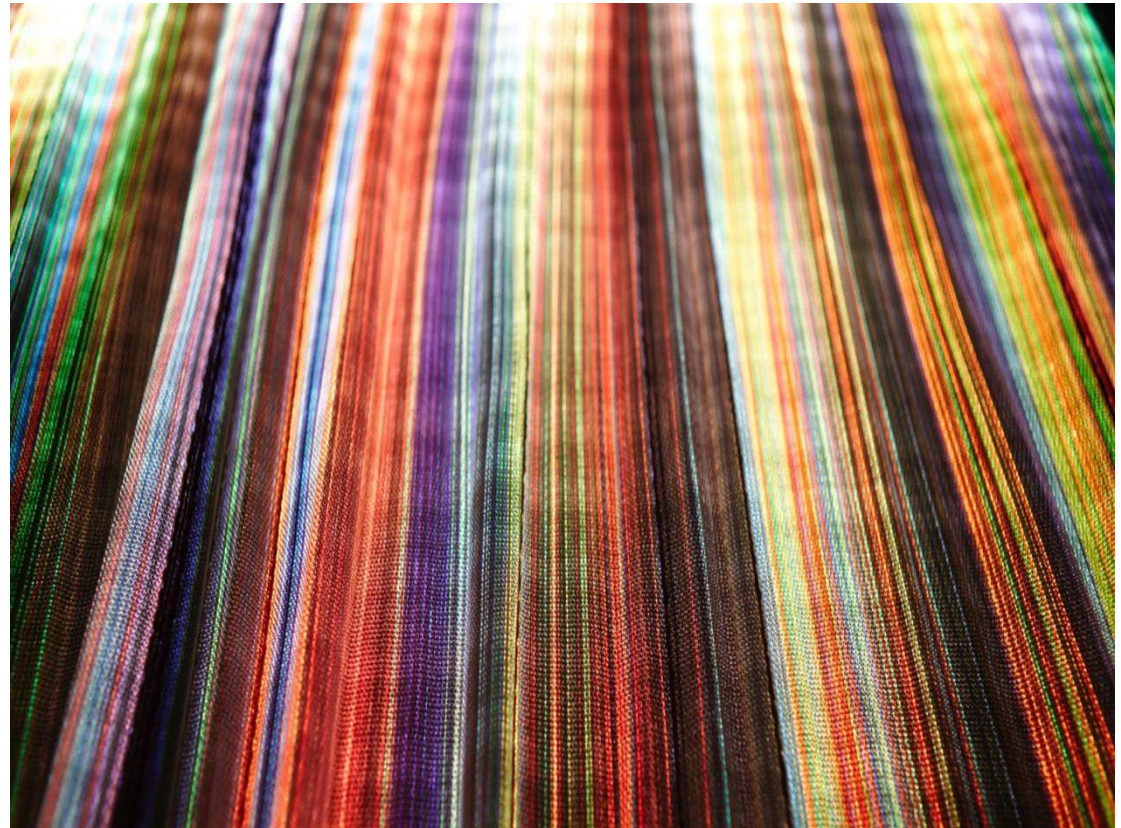
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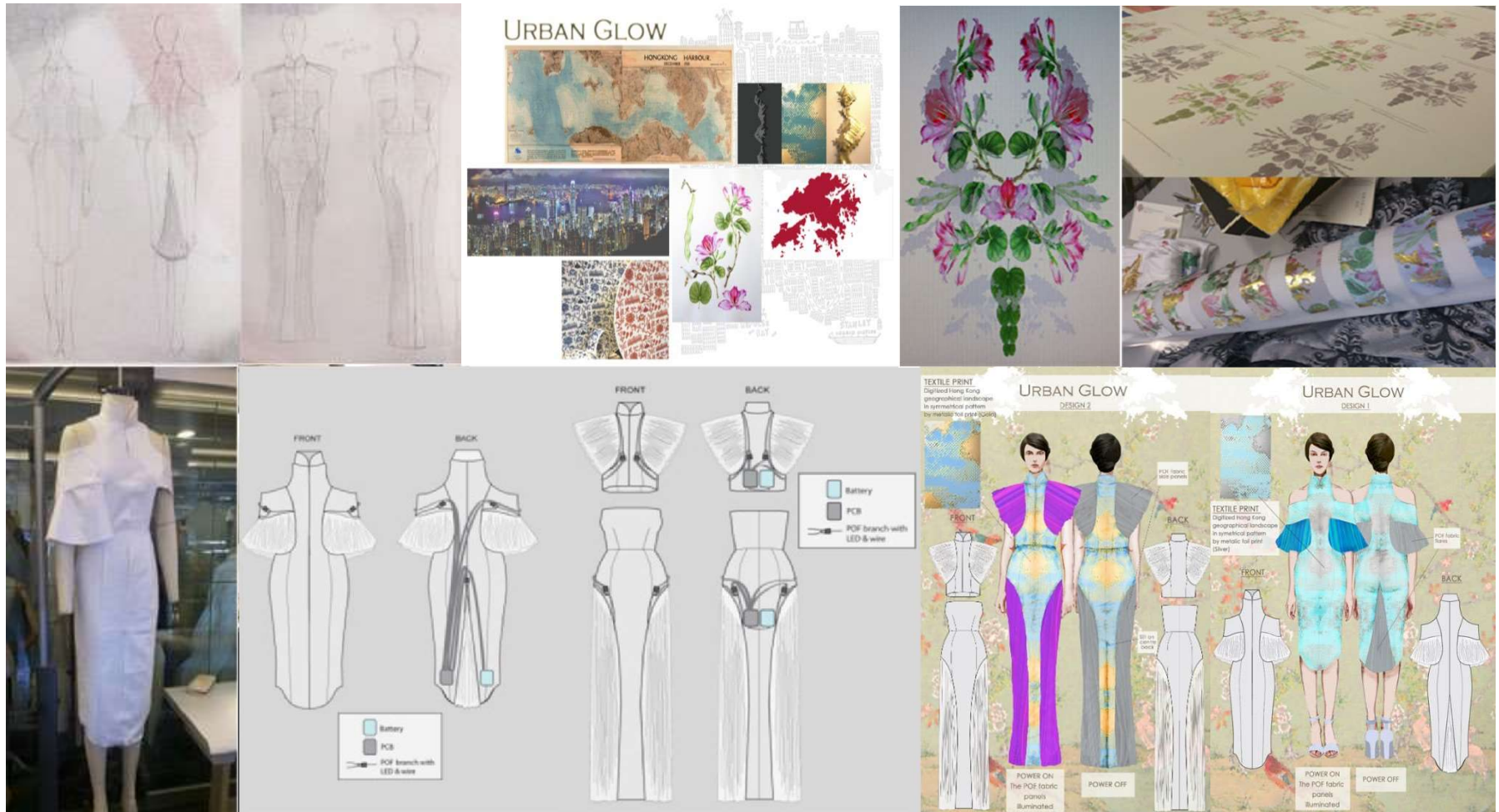
Research Methods and Materials

The research and design development involved,

- Fashion design development with consideration of the form, construction and illumination.
- Component placement: Integration of sensors and remote controls
- Laser engraving for even illumination.
- Light source connection via novel couplers.
- POF curved edges to create organic seams and shapes.



POF textile with multi-color illumination.



Design development for Urban Glow.



Design and technology integration development for Totem.

Inspired by totemic mythology. A mix of gradient colors via digital printing and the illumination of POF textiles enables a dynamic play of colors.



Laser Engraving

Conventional POFs transmit light from one end to the other, damage on the external fibers allows the woven POF textile to emit light laterally. Early research had relied on hand etching, physical damage and chemical treatments that produced unpredictable results. This research investigates laser engraving with studies on the power, gradient pattern and repetitions for stable illumination effects.



Coupling to Light Source
Traditional connection to light source involve fussy and laborious ultraviolet bonding and curing with glue. Via extensive experiments and tests, a novel coupler based on a cable gland was developed to replace the gluing process.



POF Curved Edges

Via extensive experiments and design practice, develop novel method to overcome the limitations of applying straight seams due to woven grid structure. Unique textile deconstruction method to create curve edge. This will ensure non-cumbersome bundling of POFs around curved panels as compared to creating the illusion of a curve seam via a straight edges and a curved surface panel.

Research Conclusion

- Expand possibilities for applying interactive textiles on smart clothing with interdisciplinary design process that synergizes fashion design, textile design and technology integration.
- Transforming conventionally passive textiles into interactive fashion via the integration of sensors and software applications.
- Advanced laser engraving technique lateral luminescence whilst minimizing POF damage.
- Developed new efficient and effective light source connection method via the design of unique coupler, thus eliminating the need for fussy and laborious manual POF bundling via conventional manual glue curing..
- Previous designs had been limited to applying POF textiles in straight seams due to the grid weave structure, this research developed a new method to create curved edges on the POF textile to create contour seams.

Dissemination

(1 Book Chapter, 1 Journal Publication, 3 International Conferences, 4 Exhibitions, 2 Invited International Public Talks, 1 International Designer Residency, 2 Invited Catwalk Presentations)

Year	Book Chapter
2015	Tan, J. (2015) Photonic Fabrics for Fashion and Interiors. In Tao, X.M.(Ed.) Handbook of Smart Textiles. (1005-1033) New York: Springer. DOI: 10.1007/978-981-4451-45-1_29

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2016	Tan, J.(2016) Photonic Patterns: Fashion cutting with illuminating polymeric optical fibre textiles presented at The Second International Conference for Creative Pattern Cutting. University of Huddersfield. 24-25 February 2016. https://core.ac.uk/download/pdf/61217121.pdf
2016	Wong, W.C., Tan, J., Luximon, A. (2016) Design process of Interactive POF footwear. Paper presented at the Proceedings of Fashion: Exploring Critical Issues, 8th Global Meeting, Mansfield College, Oxford, UK, 5-7 October. http://www.inter-disciplinary.net/critical-issues/wp-content/uploads/2016/08/WongWingChung-fash8-dpaper.pdf
2016	Tan, J., Wong, W.C., Bai, B.Z. and Ge, L. (2016) Application vs Intergration: The challenges of wearable technology from a Polymeric Optical Fibres (POFs) textile perspective. Paper presented at "The New Paradigm of Global Fashion Business in ICT Convergence" organized by The Korea Society of Fashion Business 2016 International Conference. Soongsil University, Seoul, Korea. 29 October 2016.

Dissemination

Year	Exhibitions
2016	Tan, J., Wong, W.C., Zhao, C.C. (2016) Lucid Illumination at Wearable Blessings: Traditional Chinese Children's Clothing Exhibition. Hong Kong Heritage Museum, HKSAR. 18 December 2015-21 March 2016.
2013	Tan, J. (2013) Totem at Connect: Expand +. Organised Exhibition. The National Gallery Bangkok, Thailand. 6-28 November 2013 (International Juried Exhibition)
2013	Tan, J. (2013) Futuro Photonics. H4F Gallery, Shih Chien University, Taipei, Taiwan. 27 November-5 December 2013.
2013	Tan, J. (2013) Urban Glow at Legacies and Innovations Exhibition at Eslite, Taipei organized by Hong Kong Museum of History, HKSAR. 30 November to 29 December 2013.

Dissemination

Year	Invited Public Talks and International Designer Residency
2015	Tan, J. (2015) "Designing with Technology" Invited design lecture to undergraduates and PhD students Burapha University, Chonburi, Thailand. 30th -31st January 2015.
2013	Tan, J. (2013) "Futuro Photonics" at Ultra Bio International Design Conference at Shih Chien University, Taipei, Taiwan. 12 December 2013.
2017	Tan, J. (2017) Designer Residency at Burapha University, Chonburi, Thailand. 31 March-7 April 2017.



Dissemination

Year	Invited Catwalk Presentations
2018	Tan, J. (2018) Urban Glow Shishi Fashion Week in Fujian, China on April 20, 2018. The event is jointly organized by China National Textile and Apparel Council, China National Garment Association and China Fashion Association.
2013	Tan, J. & Ho H.M. (2013) Urban Glow. Fashion show at “Hong Kong Week” at Eslite Bookstore organized by the Hong Kong Museum of History. 29 November 2013.



Others

Year	IMedia (International and Local Media)
2016	Media coverage of 'Lucid Illumination' (Wearable Blessings exhibition)
2013	Media coverage of Urban Glow (Legacies & Innovations exhibition)



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Others

Year	Award
2016	Excellent paper award for Application vs Integration: The challenges of wearable technology from a Polymeric Optical Fibres (POFs) textile perspective. Paper presented at "The New Paradigm of Global Fashion Business in ICT Convergence" organized by The Korea Society of Fashion Business 2016 International Conference. Soongsil University, Seoul, Korea. 29 October 2016.

