

# Workshop on Transparent and Flexible Electrochromic Displays

Heiko Müller<sup>1</sup>, Samuel Morais<sup>2</sup>

1: University of Lapland, 2: Ynvisible Interactive Inc.

Contact Author: [heiko.muller@ulapland.fi](mailto:heiko.muller@ulapland.fi)

**Abstract.** This workshop aims to bring together researchers, designers and practitioners to discuss current challenges and opportunities of ambient displays, including application scenarios, services and new prototyping techniques. As a special focus, we will introduce electrochromic displays as a novel type of display. Throughout the workshop, participants will engage in hands-on fabrication of an electrochromic display of their own design. This will enable participants to reflect on the potential applications and design of these non-light-emitting, slow transitioning displays. Besides fabricating a display, participants will gain insights into the integration of EC displays with maker electronics and sensors.

## Workshop Background

With an increasing number of devices competing for our attention, the burden of notifications becomes higher. However, not all information is so important that requires immediate attention. Following Weiser's vision of calm computing (Weiser and Brown (1996)), ambient displays can convey information in a less obtrusive manner.

Ambient displays are displays that show information that a user is aware of, but not focused on (Matthews et al. (2003)). They e.g. notify the user about a device's state, incoming notifications or progress states, and have become ubiquitous in recent years. Their strength is that they "can move from the periphery to the focus

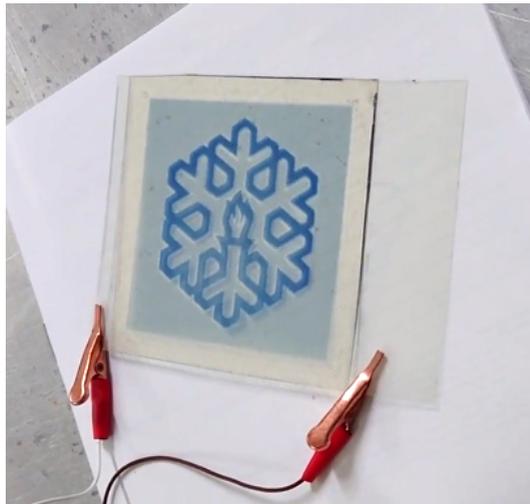


Figure 1. Ambient display based on electrochromism.

of attention and back again” (Pousman and Stasko (2006)). Probably the most popular type are ambient light displays (Matviienko et al. (2015)).

Prior work has addressed the use of ambient displays in supporting workplace awareness and communication in distributed teams (Röcker et al. (2004)). For example, as means of conveying telepresence in distributed collaborative work (Gellersen and Beigl (2000)), enhancing interactions through non-verbal support (Balaam et al. (2011)), or supporting long distance relationships (Alshehri et al. (2016); Häkkinä et al. (2018); Li et al. (2018)) to name only a few.

A number of workshops on have been organized in the past concerning ambient displays and related topics, e.g. Peripheral Interaction (Bakker et al. (2014); Hausen et al. (2013)) and in-vehicle applications (Löcken et al. (2015)). Considering advances in technologies, e.g. printed electronics (Steimle (2015)) or electrochromic displays (Granqvist (2015)), and the increased need for ambient displays, it is now timely to revisit ambient displays and discuss the progress made as well as the new opportunities that lie ahead.

The workshop invites ideas and discussions on all types of ambient displays to establish a broad overview. As a design probe, electrochromic displays will be introduced in the workshop, through a hands-on printing process (see Figure 2).

## Organizers’ Background

- **Heiko Müller** is a post-doctoral researcher in the UX team at the University of Lapland. He has a background in HCI working with ambient displays.
- **Samuel Morais** is a graphic and interface designer at Ynvisible exploring new and exciting ways of using electrochromic technology.

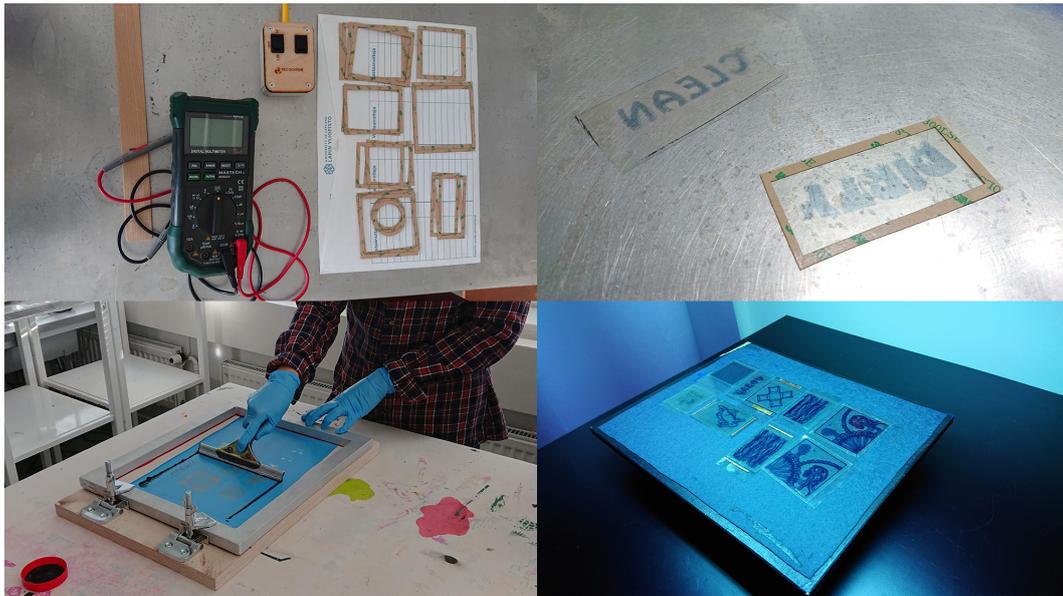


Figure 2. Creating electrochromic displays using screen printing..

## Website

The workshop webpage will be hosted at: <https://decochrom.com/workshops/ecscw2019/> The web page will be complemented with a detailed call of the workshop topics and visual material upon the acceptance of the workshop.

## Pre-Workshop Plans

Prior to the workshop, we will establish a workshop website, and distribute the call for participation through our network of contacts as well as through mailing-lists. We ask participants to sign up for the workshop via email to [decochromproject@gmail.com](mailto:decochromproject@gmail.com). The maximum capacity for the workshop will be 12 participants. We reserve the right not to run the workshop, if less than seven participants sign up.

## Workshop Structure

As part of the workshop participants will engage in the hands on production of a printed electrochromic (EC) display, based on a design they provided before the workshop. All workshop participants will leave the workshop with a functional EC display. This hands on task will be inter-woven through the workshop day (see Figure 3).

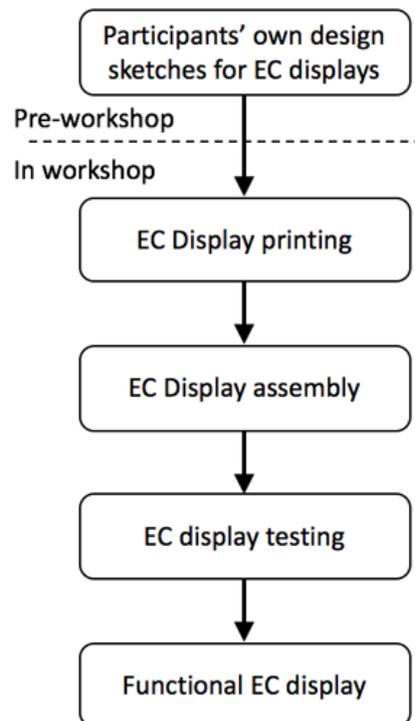


Figure 3. Workshop participants will construct an electrochromic display of their own design.

## Introducing Electrochromic Displays

The workshop will begin with an ice-breaking and introduction round. Electrochromic (EC) displays will be introduced as focus of the workshop. We will collect ideas on how EC displays can be integrated into current CSCW applications.

## Display Creation

After coffee we will start with the creation of the participants' displays. Designs made by the participants prior to the workshop will be created using different printing techniques, such as screen and inkjet printing, or spray-painting. As the preparation of the screens require some time prior to the workshop, the organizers will select a number of designs to print with this technique. Inkjet printing and spray painting require less preparation so last-minute changes can be realized as well. After printing the displays, they will be dried in an oven. Assembly includes preparation of spacer material, calculation of the amount of electrolyte needed for each display and then the act of putting everything together. Participants will conduct all these steps at the instruction of the organizers. For each step we will highlight the dos and don'ts of electrochromic displays. The display assembly will require normal motor skills to apply spacer and electrolyte material as well as aligning the two sides of the display.

## Sensor Integration

Following lunch, the organizers will lead the discussion on interaction and sensor integration with electrochromic displays. While hands-on projects by each participant will be too challenging to realize in the available time, the organizers will demonstrate integration of electronics in a sample project.

## Wrap up

In the final session of the workshop, the participants' EC displays will be fully completed, making them stable and usable. Participants will then test their EC displays and reflect on their application as ambient displays, as well as their prototyping process. We will wrap up the workshop with a feedback session, covering participants' reflections on the workshop and planning next steps.

## Post-Workshop Plans

After the workshop, we will establish a mailing list of the participants to help foster further collaboration on ambient displays. We will summarize the findings of the workshop for publication in a journal, e.g. the *International Journal of Ambient Computing and Intelligence*. Concerning electrochromic displays, we plan to release a toolkit for designers facilitating their work with this type of display.

## Call for Participation

The Workshop on Transparent and Flexible Electrochromic Displays reaches out to researchers, designers and practitioners interested in exploring calm displays suitable for "always on" information presentation. In this one-day workshop we will discuss the design challenges surrounding ambient displays. As part of the workshop, participants will produce an electrochromic display of their own design. This enables participants to reflect on the potential applications and design of these non-light-emitting, slow transitioning displays.

A short introduction to electrochromic displays and ideation phase will start off the workshop. Participants' will explore application areas for EC displays and together we will identify the opportunities and challenges with available technologies. We will explore the design challenges when working with calm and ambient displays, and discuss issues such as sensor integration and interaction paradigms.

In parallel to the ideation and discussion activities, participants will assemble their own electrochromic display, based on their own design sketches provided to the organizers' pre-workshop. The assembly requires normal motor skills to apply spacer and electrolyte material as well as align the two sides of the display. At end of

the day, all participants will take home their own designed functional electrochromic display.

No particular prior expertise is required to join the workshop. To register for the workshop send an email to [decochromproject@gmail.com](mailto:decochromproject@gmail.com). We will accept up to 12 participants to the workshop. We reserve the right to cancel the workshop if less than seven participants register. You can find additional information on the workshop's website: <https://decochrom.com/workshops/ecscw2019/>.

## Acknowledgments

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 760973.

## References

- Alshehri, M., V. Shanthagiri, and K. Connelly (2016): 'Forget Me Not: An Ambient Display to Increase Communication Between Partners by Enabling Feeling Expression and Increasing Awareness'. In: *Proceedings of the 10th EAI International Conference on Pervasive Computing Technologies for Healthcare*. ICST, Brussels, Belgium, Belgium, pp. 223–226, ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering).
- Bakker, S., D. Hausen, T. Selker, E. van den Hoven, A. Butz, and B. Eggen (2014): 'Peripheral Interaction: Shaping the Research and Design Space'. In: *CHI '14 Extended Abstracts on Human Factors in Computing Systems*. New York, NY, USA, pp. 99–102, ACM.
- Balaam, M., G. Fitzpatrick, J. Good, and E. Harris (2011): 'Enhancing interactional synchrony with an ambient display'. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. pp. 867–876.
- Gellersen, H.-W. and M. Beigl (2000): 'Ambient telepresence: Colleague awareness in smart environments'. In: *Managing Interactions in Smart Environments*. Springer, pp. 80–88.
- Granqvist, C.-G. (2015): 'Electrochromic metal oxides: an introduction to materials and devices'. In: *Electrochromic Materials and Devices*. Wiley-VCH Weinheim, Germany, pp. 3–40.
- Häkkinen, J., H. Li, S. Koskinen, and A. Colley (2018): 'Connected Candles As Peripheral Emotional User Interface'. In: *Proceedings of the 17th International Conference on Mobile and Ubiquitous Multimedia*. New York, NY, USA, pp. 327–333, ACM.
- Hausen, D., S. Bakker, E. Van den Hoven, A. Butz, and B. Eggen (2013): 'Peripheral interaction: embedding HCI in everyday life'. *Peripheral Interaction: Embedding HCI in Everyday Life*, pp. 1.
- Li, H., J. Häkkinen, and K. Väänänen (2018): 'Review of Unconventional User Interfaces for Emotional Communication Between Long-distance Partners'. In: *Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services*. New York, NY, USA, pp. 18:1–18:10, ACM.
- Löcken, A., S. S. Borojeni, H. Müller, L. Chuang, R. Schroeter, I. Alvarez, and V. Meijering (2015): 'Workshop on Adaptive Ambient In-Vehicle Displays and Interactions'. In: *Workshop*

- on Adaptive Ambient In-Vehicle Displays and Interactions In conjunction with Automotive'UI 2015 (WAADI'15)*. pp. 1–4.
- Matthews, T., T. Rattenbury, S. Carter, A. Dey, and J. Mankoff (2003): 'A peripheral display toolkit'. *University of California, Berkeley Technotes, UCB//CSD-03-1258*, vol. 168.
- Matviienko, A., M. Rauschenberger, V. Cobus, J. Timmermann, J. Fortmann, A. Löcken, H. Müller, C. Trappe, W. Heuten, and S. Boll (2015): 'Towards new ambient light systems: a close look at existing encodings of ambient light systems'. *Interaction Design and Architecture (s)*. 2015;(26): 10-24.
- Pousman, Z. and J. Stasko (2006): 'A taxonomy of ambient information systems: four patterns of design'. In: *Proceedings of the working conference on Advanced visual interfaces*. pp. 67–74.
- Röcker, C., T. Prante, N. Streitz, and D. van Alphen (2004): 'Using ambient displays and smart artefacts to support community interaction in distributed teams'. In: *Proceedings of the OZCHI Conference*. pp. 22–24.
- Steimle, J. (2015): 'Printed Electronics for Human-Computer Interaction'. *Interactions*, vol. 22, no. 3, pp. 72.
- Weiser, M. and J. S. Brown (1996): 'Designing calm technology'. *PowerGrid Journal*, vol. 1, no. 1, pp. 75–85.