What is the biggest impact that chemistry has had in the last 100 years?

The chances are if you have written an email on a computer, looked at the time on a digital clock, or watched some TV you have interacted with a Liquid Crystal Display (LCD). I am going to explore how the chemistry behind the LCD has enabled it to fill a critical role in the digital era.

LCDs are constructed in layers: a light source, then a polarising filter, then a liquid crystal mixture, then another polarising filter rotated 90 degrees to the first, and finally a screen to protect the internal components. There are two different methods used for the light source, transmissive and reflective. The reflective method is where the light is provided by an external source and reflects off a mirror behind the polarising filter, this method uses the least power and is often used in digital clocks. Transmissive is where the light is provided by an internal component (e.g. an LED) though this uses more power it provides greater illumination

Liquid crystal refers to materials that flow like liquids and display structural arrangements, like that of solid crystals.[1] Molecules that exhibit these properties are called liquid crystal monomers. Whilst many molecules exhibit liquid crystal properties most of them follow this generic blueprint: 1. Two benzene rings grant planarity 2. A slightly polar terminal group, causing intermolecular attraction 3. A hydrocarbon side chain increasing molecular length.[2] There is concern to the safety of LCMs as a recent study found that of 362 currently used LCMs, 87 were toxic.[3] . However, the small quantities used in LCD screens are unlikely to be harmful.

LCMs for different structural arrangements, one of them is the nematic phase, this is where the molecule is arranged so all the LCMs have the same orientation. However, the most important structure is the twisted nematic structure, this occurs as chirality in LCMs allows successive layers to

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[1] Mahan, GD, and Widom, M,. "Liquid Crystal | Physics," Encyclopædia Britannica (2013) [https://www.britannica.com/science/liquid-crystal last accessed 2nd Jan. 2021]

[2] L. Stephen., Liquid Crystals, 15th Aug. 2020. [https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Physical_Properties_of_Matter/States_of_Matter/Liquid_Crystals, last accessed: 2nd Jan. 2021]

[3] Su. H, Shi. S, Zhu. M., Crump. D., Letcher. R., Giesy. J, and Su. G., "Persistent, bioaccumulate, and toxic properties of liquid crystal monomers and their detection in indoor residential dust", National Academy of Sciences 116:56 (2019): 26450

rotate the plane of polarised light. This is particularly useful in LCDs as the light source first passes through one polarising filter, then the liquid crystal mixture and then another polarising filter, orientated at 90 degrees to the first. This means that if the light goes through the first filter and is polarised in one direction and if the LCM mixture is in a nematic phase the polarisation of the light would not be affected and it would be fully blocked by the second polarising filter. However, when the light passes through a twisted nematic structure the light is polarised 90 degrees again meaning it can pass through the second polarising filter meaning light will shine from the display. We can control the state that the LCMs are in by applying an electric field to the mixture changing parts of the mixture from nematic to twisted nematic phases and subsequently control the areas that light is able to pass through and therefore allowing us to create images.[4]

In conclusion, the biggest impact that chemistry has had in the last 100 years is the LCD because it has enabled us to display and interact with the digital world that is so intertwined with our reality.

[4] H. Shawn., "Adventures in science: How LCD Works", 30th Jan. 2018, [https://www.youtube.com/watch?v=VbdhbyiHX-s last accessed: 2nd Jan. 2021]

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