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Elemental Analysis of Cosmetic Contact Lenses Reveals High Concentrations of Heavy Metals in Pigments Deposited on Cornea-Facing Surfaces.

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The cosmetic use of coloured contact lenses (CCL) has grown over the past few years. Coloured lenses prescribed by eye care professionals are shown to be safe [1] but a significant number of people (30-43% of people) purchase CCLs from online vendors or in shops without an eye exam or professional advice regarding handling and lens hygiene [2].

Previous studies into CCL pigmentation show varied results in lens quality. There appear to be three main types: lenses with pigment on or close to the surface on the outer (eyelid-facing) surface, lenses with pigment on the inner (cornea-facing) surfaces, and lenses where the pigment is sandwiched between clear material [3,4]. CCL with pigments on the surface of the lenses appear to have an increased incidence of: pigment detachment following mild abrasion [5], bacterial contamination [5], irritation of ocular surfaces [4], and have a greater chance of causing significant damage to the cornea [6]. Indeed, analysis of CCLs from different countries have indicated the presence of potentially cytotoxic elements, such as iron, [6, 7], although the distribution and concentration of elements on CCLs available in the UK has not been well studied.

Therefore, we aimed to further investigate the location, durability and chemical composition of CCL pigments across various CCL designs purchased from online UK-based retailers. Lenses were delivered in saline within sterile packaging. Each lens was thoroughly rinsed 4 times with deionised water. Excess water was wicked off using filter paper. The rub-off test was performed according to Chan et al., [5] on one lens from each pair. The second lens was cut into rough quarters and placed on fresh filter paper, covered, and left to dry overnight. The pieces of lenses were mounted onto aluminium stubs using conductive carbon tabs in different orientations to ensure that both the inner and outer surfaces were analysed. The samples were coated with ~10-20nm carbon and imaged using a Tescan S8000 scanning electron microscope (SEM) with an accelerating voltage of 5kV and a beam current of 1na. Energy dispersive x-ray spectrometry (EDS) was performed using an Oxford Instruments Ultim Extreme, with the same operating conditions, to determine the chemical composition of pigments.

All the lenses passed a rub-off test with no sign of pigment detachment onto the cotton bud. SEM analysis revealed smooth surfaces on lenses with a single colour and no pattern. All but 1 of the patterned CCLs had pigment deposited on the inner surface of the lens. Chemical analysis revealed that the most common elements found in the pigments were carbon, oxygen, nitrogen, chlorine, phosphorous, iron and copper. The quantities varied considerably across the patterns of the pigments and iron in particular was found in very high quantities (>25 WT%) in one sample.

Our analysis indicated that cytotoxic elements were found in pigments that came into direct contact with ocular surfaces for almost all of the CCLs tested. While there was no evidence for significant pigment detachment in any of the lenses examined, the durability test we employed was of a simple nature, with only one timepoint taken and no measure of nanoparticle release. Given the surprisingly high levels of

cytotoxic chemicals found in some of the lenses, further investigation into pigment durability after a standard 12-24 hr period of use is warranted. In addition, the potential for exposure to nanoparticles onto the cornea over time remains a concern. As such, we are currently using EDS to quantify potential uptake of nanoparticles into macrophages grown on the surface of CCLs.

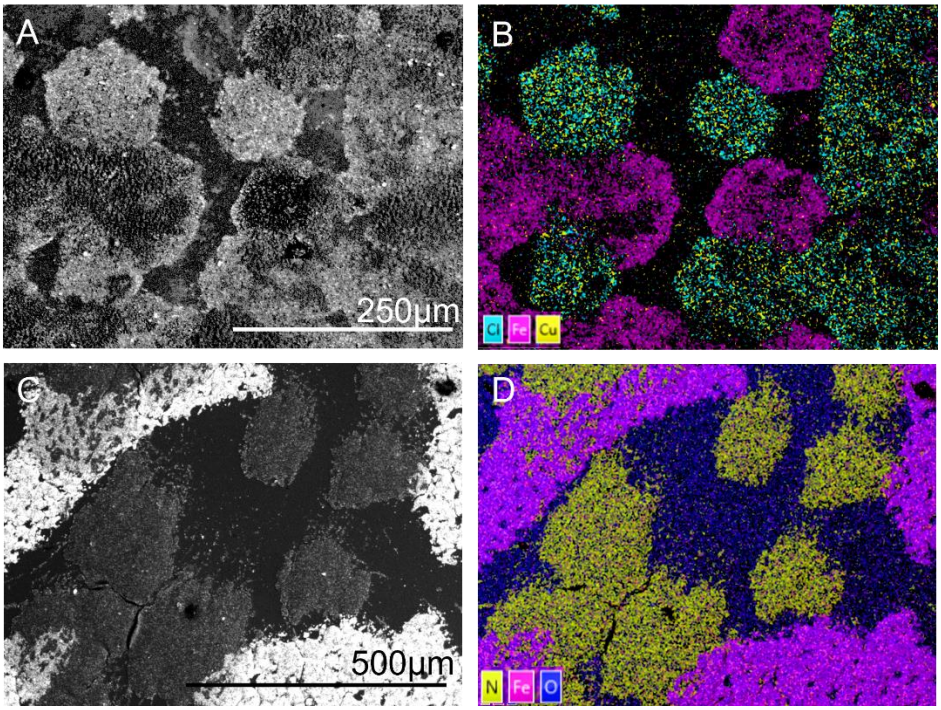

Figure 1. Backscattered electron images (A, C) and layered EDS maps (B, D) showing the distribution of iron, copper, chlorine, nitrogen, and oxygen in two patterned CCLs with pigment presence on the inner surface of the lens.

References:

[1] Rah MJ, Schafer J, Zhang L, Chan O, Roy L, Barr JT. Clin Ophthalmol. 7 (2013) p2037-42. doi: 10.2147/OPTH.S51600.

[2] Cope JR, Collier SA, Nethercut H, Jones JM, Yates K, Yoder JS. MMWR Morb Mortal Wkly Rep (2017) p841–845. DOI: https://www.cdc.gov/mmwr/volumes/66/wr/mm6632a2.htm

[3] Korde V, McDow K, Rollins D, Stinchcomb R, and Esposito H. Eye & Contact Lens, 46(4) (2020) p.228. DOI: 10.1097/ICL.0000000000000632

[4] Hsu M-Y, Hong P-Y, Liou J-C, Wang Y-P, and Chen C. International Journal of Optomechatronics, 14:1 (2020) p119-130 DOI: 10.1080/15599612.2020.1859657

[5] Chan KY, Cho P, and Boost M. Cont Lens Anterior Eye 37 (4) (2014) 267–272. DOI: 10.1016/j.clae.2013.12.002

[6] Watanabe T, Uematsu M, Mohamed YH, Eguchi H, Imai S, Kitaoka T. Eye Contact Lens. 2018 Sep;44 Suppl 1:S322-S325. DOI: 10.1097/ICL.0000000000000306

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