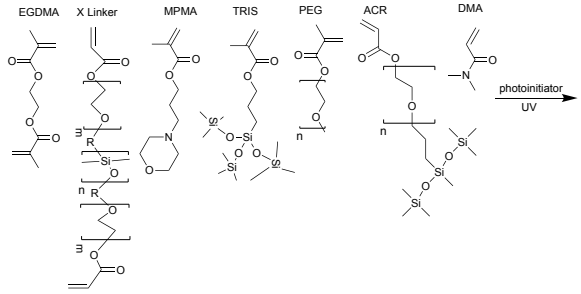
Contact Lens Mediated Drug Delivery for the Treatment of Ocular Diseases

Talena Rambarran*, Lina Liu*, Heather Sheardown*
Darren Stirland, Michael Manzo, Brenda Mann
***Department of Chemical Engineering, McMaster University | Kiora Pharmaceuticals**

Statement of Purpose: The topical delivery of drugs to the surface of eye is inefficient due to natural clearance mechanisms which prevents up to 95% of the drug from penetrating the cornea and sclera tissues. While the use of contact lenses as a drug delivery vehicle is promising, many deliver the therapeutic too quickly (1-2 h) or release the drug over many days. There remains a need for a contact lens that can load a high concentration of drug and deliver it throughout the day. The purpose of this work was to develop a contact lens that can effectively load ocular therapeutics and facilitate their controlled release to the eye. A new lens material containing a positively charged monomer was created to facilitate the loading and release of negatively charged therapeutics, over the period typical of contact lens use (4-24 h).

Methods: *Material synthesis:* Model silicone hydrogel (SiHy) materials (components Scheme 1) with and without 3-(N-morpholino)propyl methacrylate (MPMA) were created by mixing the components with a small amount of alcohol and exposing them to UV light (365 nm), optionally including the drug.



Scheme 1: Silicone hydrogel components

Drug Loading: Dexamethasone phosphate (DexP) was loaded directly into the hydrogel prior to crosslinking with the monomers of Scheme 1 (with and without MPMA). Following the curing procedure, the materials were rinsed with water followed by 2-propanol and the wash solutions were analyzed by HPLC. Drugs were also loaded into preformed materials (with and without MPMA) by soaking prewashed and dried disks of the model lenses for 48 h in solutions of 4 different drugs: DexP, Prednisolone phosphate (PredP–negative charge), Metronidazole (Met–neutral) and Tobramycin (Tobr-positively charged). After drying the disks were weighed to determine the amount loaded.

Drug Release: SiHys with and without MPMA were extracted and then soaked in a solution of DexP for several days, blotted and then released into PBS. The concentration released was measured using UV.

Results: When DexP was loaded directly into the material, the SiHy containing MPMA lost ~ 10x less DexP during the IPA wash compared to the SiHy with no MPMA. The results demonstrate the influence the MPMA monomer has on improving drug incorporation into the material and limiting its potential loss during extraction procedures which are necessary during contact lens manufacturing. The amount of negatively charged drugs loaded into the MPMA containing SiHy by soaking significantly increased compared to the non-MPMA material. The presence of MPMA did not influence loading of the neutral or positively charged drugs (Figure 1 top). As seen in Figure 1 bottom, the total amount of DexP released was much greater when MPMA was incorporated into the material. Overall, the developed contact lens material containing MPMA for ocular drug delivery is advantageous since it can aid in loading high concentrations of negatively charged therapeutics and assist in their controlled delivery throughout the day which may help the therapeutic penetrate to the posterior segments of the eye.

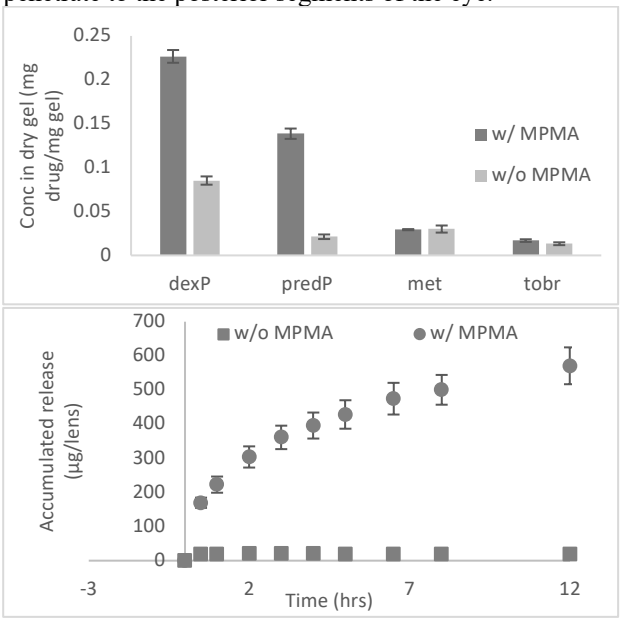


Figure 1: Comparing the SiHy with and without the MPMA monomer 1. (Top) The amount of different drugs loaded after 48 h soaking and 2. (Bottom) DexP release after drug loading via soaking preformed and extacted materials.

References: Mann, B.; Stirland, D.; Manzo, M.; Sheardown, H.; **Rambarran, T.;** Liu, L. "Compositions and Methods for Treating Ocular Disease by Contact Lens Mediated Drug Delivery," US Patent Appln 17/209645, **2021.**