THE EFFECT OF HYDROPHILIC MONOMERS ON SILICONE-BASED HYDROGELS PROPERTIES

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Introduction

Many efforts have been done in order to overcome the problems of conventional ocular treatments. Therapeutic soft contact lenses (CL_s) have gained special attention and different strategies to obtain controlled drug release profiles have been followed.
Silicone hydrogel CL_s are the most commonly used worldwide. This type of lenses **allows much more oxygen to reach the cornea** than conventional hydrogel CL_s. However, the silicone compounds can reduce the surface wettability of the lenses, decreasing the users comfort. To overcome this problem, the new silicone CL_s include hydrophilic monomers and/or special wetting agents.

The aim of this work is to **study the effect of two different hydrophilic monomers**, DMA N,N-Dimethylacrylamide and HEMA (2-Hydroxyethyl methacrylate), **on the properties of a TRIS-based hydrogel.**

Methods

Hydrogels Production

It was produced two types of silicone hydrogels, only varying the hydrophilic component (DMA or HEMA).

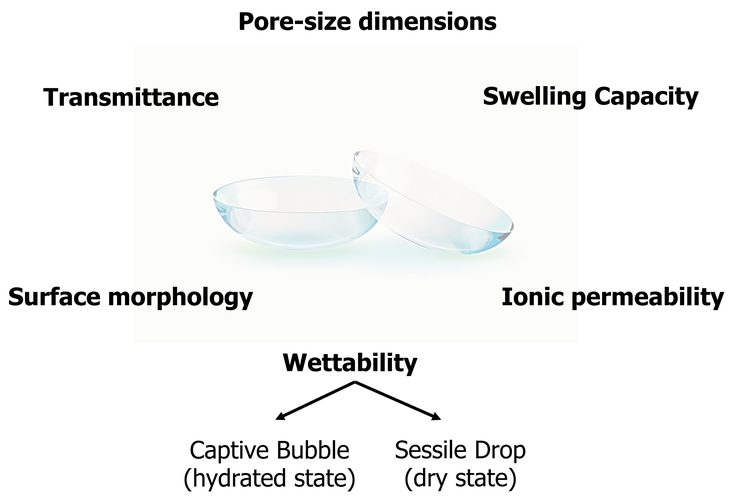
TRIS/NVP/DMA (40:40:20 w/w) | **TRIS/NVP/HEMA (40:40:20 w/w)**

Monomers:
- Silicone component:
  - TRIS (3-[Tris(trimethylsiloxy)silyl]propyl methacrylate)
- Hydrophilic components:
  - DMA (N,N-Dimethylacrylamide)
  - HEMA (2-Hydroxyethyl methacrylate)
- Other components:
  - NVP (N-Vinylpyrrolidone)

Crosslinker and Initiator:
- EGDMA (Ethylene glycol dimethacrylate)
- AIBN (2,2'-Azobis(2-methylpropionitrile))

Polymerization reaction:
- UV radiation for 120 minutes (TRIS/NVP/DMA);
- Oven at 60°C for 24 h (TRIS/NVP/HEMA).

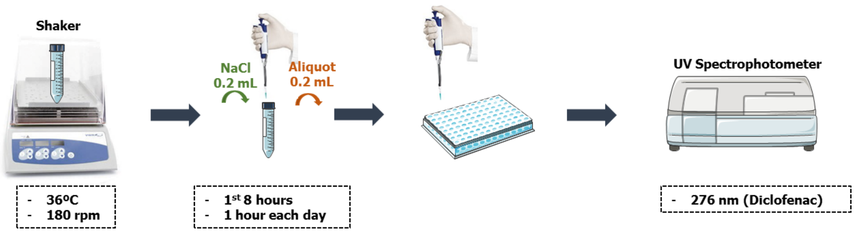
Hydrogels Characterisation



Loading & Release of Diclofenac

Loading Conditions	
Drug	Diclofenac Sodium Salt
Loading Solution	NaCl
Loading Solution Volume	3 mL
Temperature	4ºC
Loading Time	38 hours
[] mg/mL Loading	1 mg/mL

Release Procedure



Results

1. Transmittance

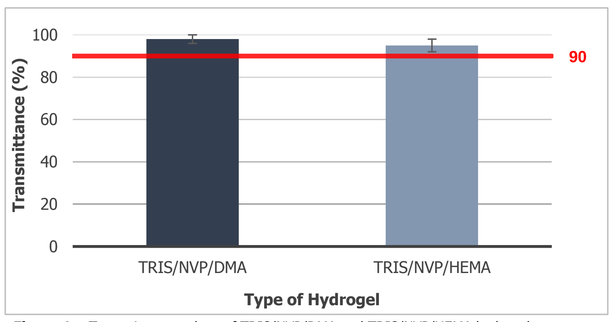


Figure 1 – Transmittance values of TRIS/NVP/DMA and TRIS/NVP/HEMA hydrogels.

All transmittance values are above the minimum accepted value, which is **90%**[1].

2. Swelling Capacity

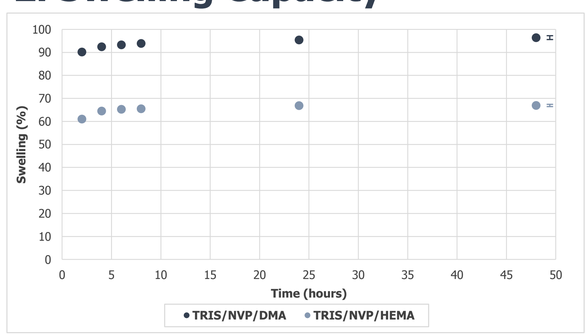


Figure 2 – Swelling capacity of TRIS/NVP/DMA and TRIS/NVP/HEMA hydrogels.

TRIS/NVP/DMA hydrogel has higher swelling percentage, proving the **good capacity of DMA to absorb water**.

3. Ionic Permeability

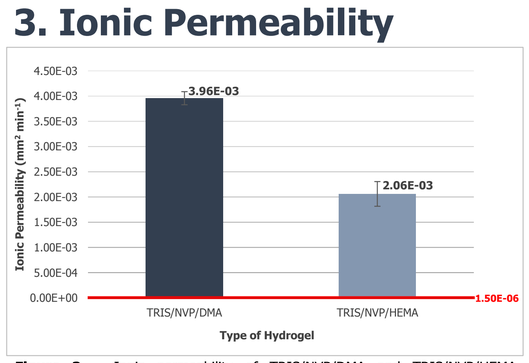


Figure 3 – Ionic permeability of TRIS/NVP/DMA and TRIS/NVP/HEMA hydrogels. The red line indicates the minimum accepted value to have an adequate on-eye movement of the lens[2].

The value of the ionic permeability of TRIS/NVP/DMA is higher than that of the TRIS/NVP/HEMA. This result is in accordance with the swelling capacity values obtained.

4. Wettability

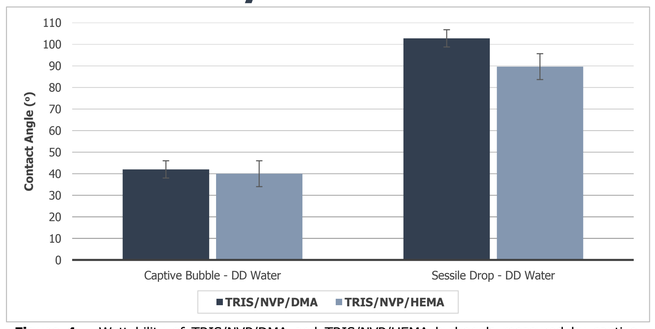


Figure 4 – Wettability of TRIS/NVP/DMA and TRIS/NVP/HEMA hydrogels measured by captive bubble and sessile drop method and using distilled and deionized water (DD Water).

Both hydrated samples presented identical values (≈40º) showing to be **highly wettable in their hydrated state**.
On the other hand, in the sessile drop method, the samples showed contact angles close to 90º, which leads to the conclusion that these hydrogels are **poorly wettable when in their dry state**. This contradictory result can be explained by the **surface roughness of the dry hydrogels, according to the Cassie-Baxter model**[3].

5. Morphology

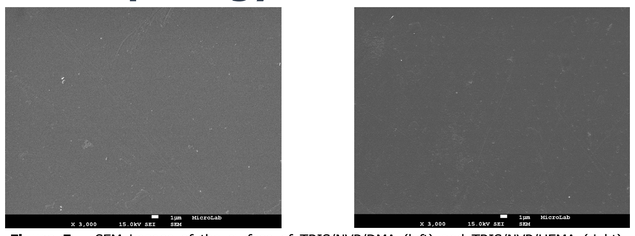


Figure 5 – SEM images of the surface of TRIS/NVP/DMA (left) and TRIS/NVP/HEMA (right) hydrogels.

Both samples present similar surface morphologies.

6. Cumulative Diclofenac Release

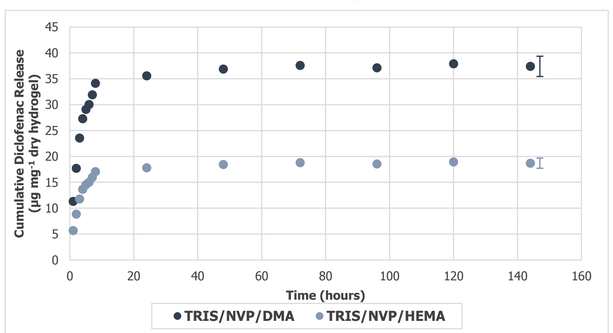


Figure 6 – Cumulative diclofenac release of TRIS/NVP/DMA and TRIS/NVP/HEMA hydrogels.

The amount of diclofenac released was significantly higher for TRIS/NVP/DMA; this means a higher loading capacity which may be explained by its greater swelling capacity and larger pores.

7. Pore-size Dimensions

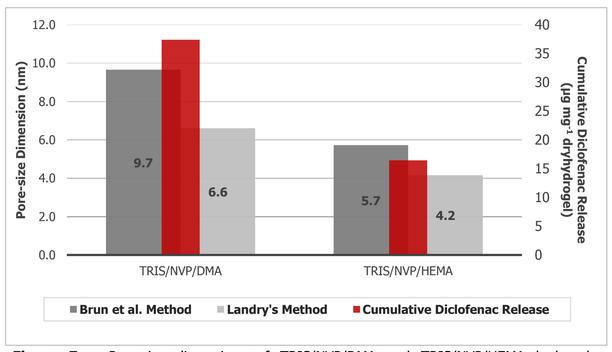


Figure 7 – Pore-size dimensions of TRIS/NVP/DMA and TRIS/NVP/HEMA hydrogels, determined through DSC measurements and using the methods proposed by Brun et al.[4] and Landry[5]. The red bars represent the cumulative diclofenac release of each type of hydrogel used to relate with pore-size dimensions.

The values obtained for the pore-size dimensions, based on calorimetric determination of the melting point depression of water and using the Landry's and Brun's equations, show that the pores are larger in TRIS/NVP/DMA.

Conclusions

DMA showed to be a better hydrophilic compound than HEMA, because it confers to the hydrogel higher swelling capacity, ionic permeability and larger pore-size dimensions, which consequently lead to a higher cumulative diclofenac release.
The hydrogels properties as well as the amount of drug released are very sensitive to the type of hydrophilic monomer present in their composition.

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