STEREOLITHOGRAPHY 3D PRINTED LONG-ACTING INTRAOCULAR IMPLANTS FOR POSTERIOR SEGMENT DISEASE

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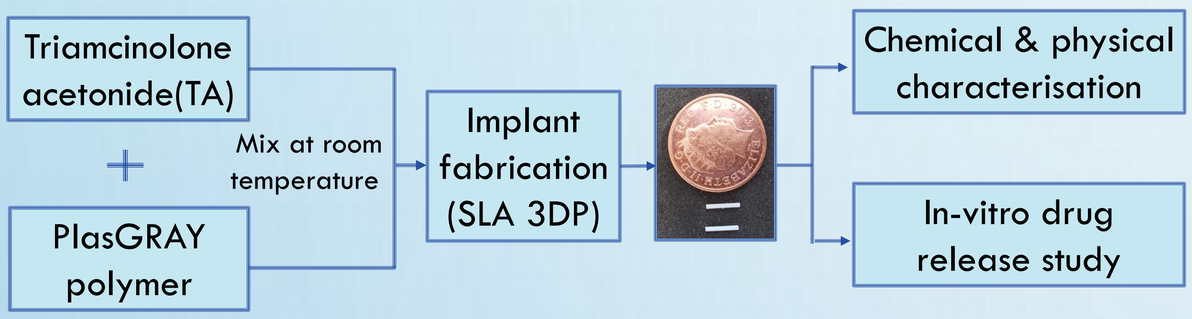
INTRODUCTION

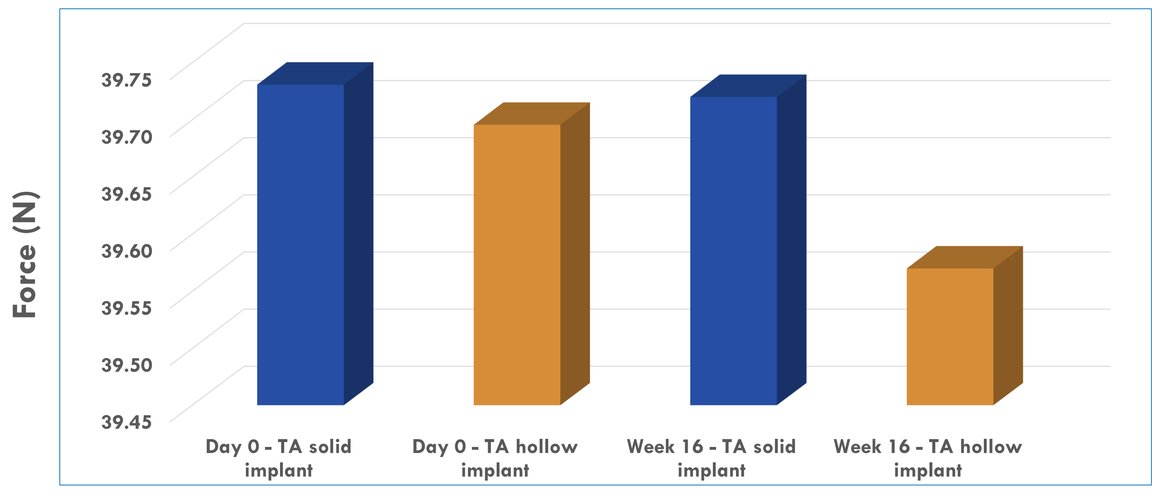
- Drug delivery to the posterior segment of the eye remains challenging because of the anatomical and physiological barriers of the eye[1].
- Sustained release ocular implants can minimize the side effects and improve patient compliance[2].
- 3D-printing technology can aid in fabrication of micron-sized implants with high precision, desired size/shape, and tailored release profiles[3].
- To date, the usage of 3D-printing technology to fabricate intraocular implants has not been widely developed.
- In this study, a long acting intraocular implant of triamcinolone acetonide (TA) was fabricated using stereolithography (SLA) 3D-printing technology. The implants were characterized for chemical/physical characterizing and drug content release.

METHODS



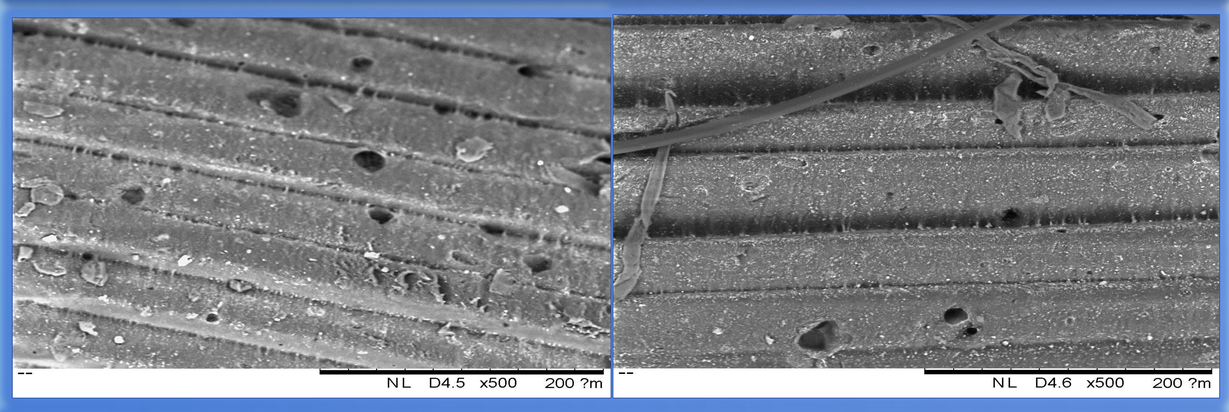
RESULTS AND DISCUSSIONS

Mechanical Strength of Implants



The results of mechanical strength showed that no significant difference was observed in implant hardness after the drug release study for 16 weeks (p=0.05).

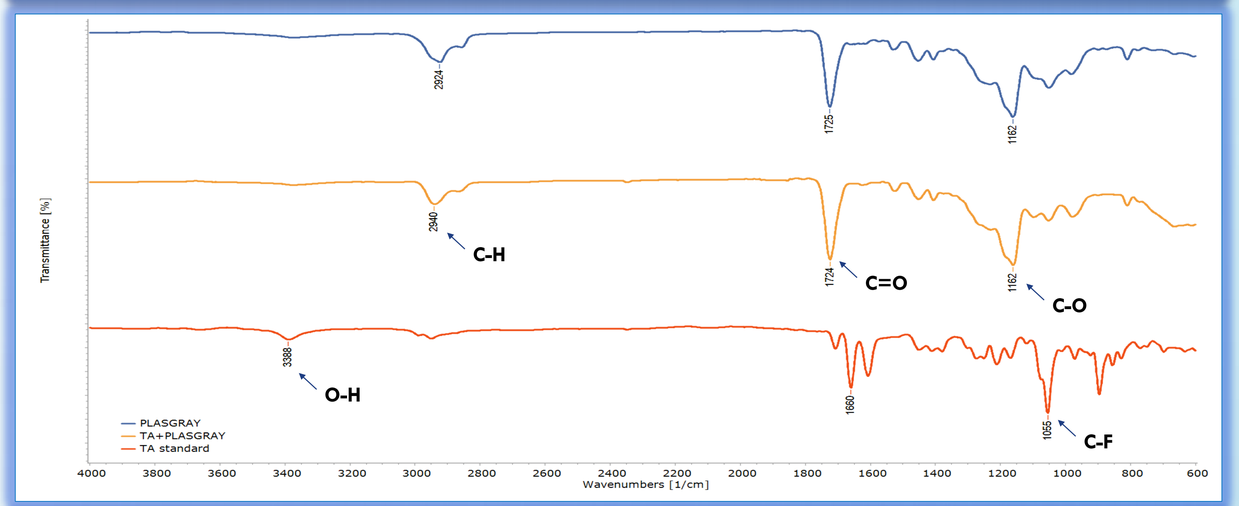
SEM Images



SEM images of TA-loaded PlasGRAY implant: (left) before drug release study & (right) after 16-week of drug release study. SEM test results showed no changes in the surface texture of the implants after the implants were incubated for 16 weeks in PBS at pH 7.4. This results can be caused by the characterisctics of PlasGRAY polymer which is non-degradable.

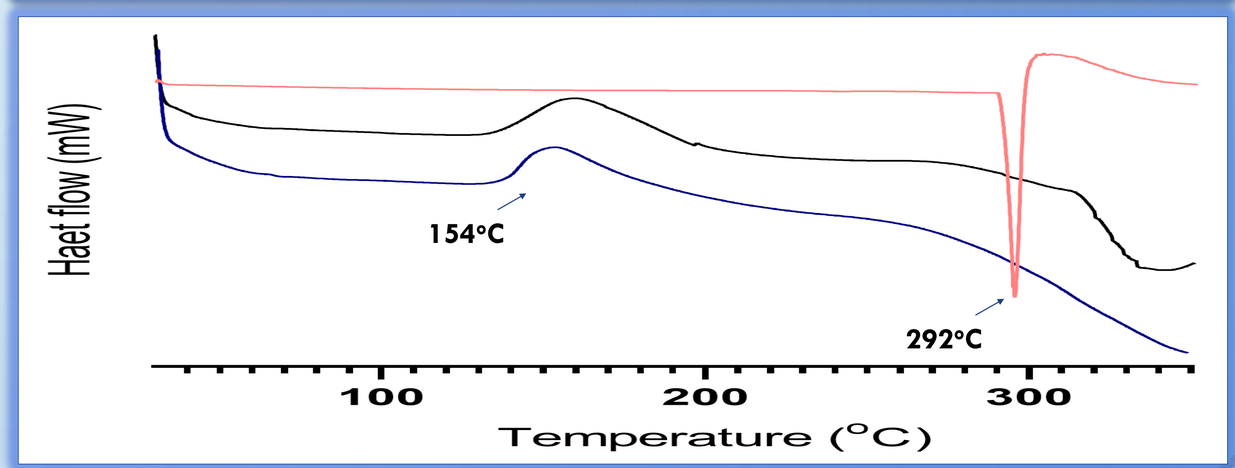
RESULTS AND DISCUSSIONS

FTIR Analysis



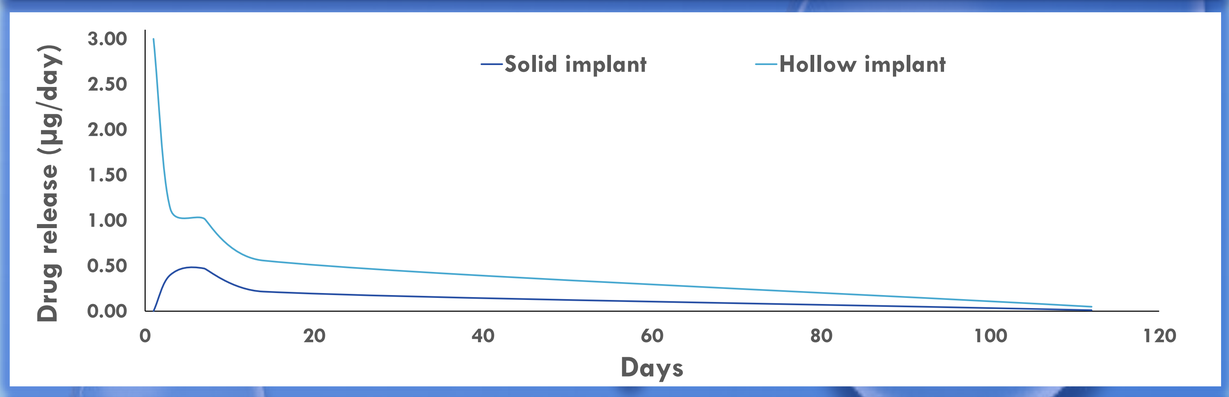
- FTIR spectra of TA standard shows a characteristic IR absorption band at 3388 cm^{-1} that associated with the stretching vibration of OH group. Strong intensity at 1660 cm^{-1} represents stretching vibration of the carbonyl group at aliphatic ester bonds.
- IR spectra of TA at 1056 cm^{-1}, associated with stretching vibration of C-F. PlasGRAY polymer showed absorption bands at 2940 cm^{-1} that associated with stretching vibration of C-H ethyl bonds. Absorption bands at 1724 cm^{-1} and 1162 cm^{-1} are typical for C=O ester bonds and C-O ester, respectively.
- The TA loaded PlasGRAY revealed all spectra components of PlasGRAY, presumed that the polymer concealed the FTIR spectra of TA at low concentration (5% w/w). A very similar spectra of TA loaded PlasGRAY to that of PlasGRAY showed that no significant chemical changes occurred in the polymer.

DSC Analysis



- The characteristics sharp endothermic peak of TA at 292°C related to it's crystalline melting temperature[4].
- The PlasGRAY implant without TA addition exhibited an exothermic peak at 154°C which implies that some of the amorphous structure in the material had undergone molecular rearrangements and converted to a structured properties leading to crystalline formations during the heating process.
- The absence of the endothermal peak of TA confirmed that TA finely dispersed at the polymer matrix during processing.

In-vitro TA drug release



- TA released from both types of PlasGRAY implants was slow. Solid and hollow implants released only 0.02 and 0.07 µg/day of TA in 16 weeks, respectively. This results caused by the high crosslinking density between TA and PlasGRAY polymer[5].

CONCLUSION

Sustained release implants were successfully fabricated using SLA-3D printing method. This result provides insight into further fabrication of ocular drugs using biodegradable polymer.

REFERENCES

1. T.R. Thrimawithana, S. Young, C.R. Bunt, C. Green, R.G. Alany, Drug delivery to the posterior segment of the eye, Drug Discov. Today. 16 (2011) 270–277. http://dx.doi.org/10.1016/j.drudis.2010.12.004.
2. S.S. Lee, P. Hughes, A.D. Ross, M.R. Robinson, Biodegradable implants for sustained drug release in the eye, Pharm. Res. 27 (2010) 2043–2053.
3. S.J. Trenfield, A. Awad, A. Goyanes, S. Gaisford, A.W. Basit, 3D Printing Pharmaceuticals: Drug Development to Frontline Care, Trends Pharmacol. Sci. 39 (2018) 440–451.
4. E. García-Millán, M. Quintáns-Carballo, F.J. Otero-Espinar, Solid-state characterization of triamcinolone acetonide nanosuspensiones by X-ray spectroscopy, ATR Fourier transforms infrared spectroscopy and differential scanning calorimetry analysis, Data Br. 15 (2017) 133–137. http://dx.doi.org/10.1016/j.dib.2017.09.002.
5. Hussein MA. Role of Cross-Linking Process on the Performance of PMMA. Int J Biosens Bioelectron. 2017;3(3):279–84.