Photocurable nanocomposites for stereolithography

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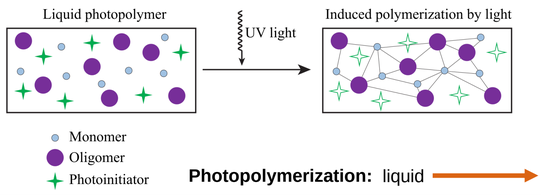
BACKGROUND

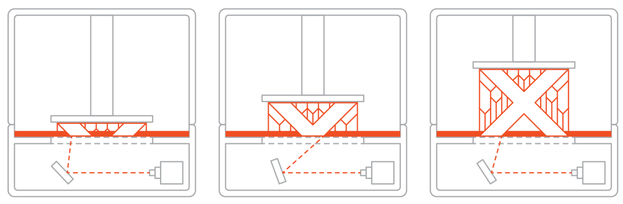


Photopolymerization: liquid → solid

3D printing technologies present plethora of possibilities of manufacturing devices. One of main techniques is stereolitography, a method that uses photopolymers.

We can make nanocomposites composed of photopolymers and nanoparticles, and then use them for 3D printing. Printed object can exhibit new properties, depending on materials used

STEREOLITOGRAPHY



https://all3dp.com/1/types-of-3d-printers-3d-printing-technology/

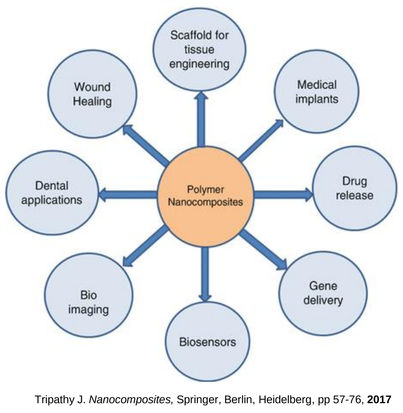
ceramics
metals
polymers

MATRIX + NANOFILLER → NANOCOMPOSIT

different types of nanoparticles, nanoclays ...

combined (enhanced) properties

MOTIVATION

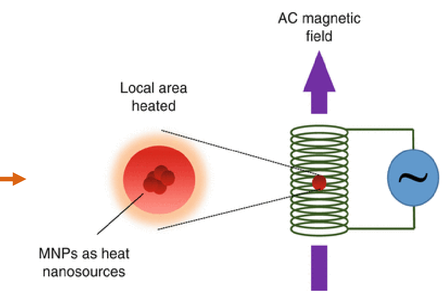


Tripathy J. *Nanocomposites,* Springer, Berlin, Heidelberg, pp 57-76, **2017**

Polymer nanocomposites find numerous potentail applications in industry, science and engineering. However, there is still a lot of room for improvment of their properties before their large-scale usage.

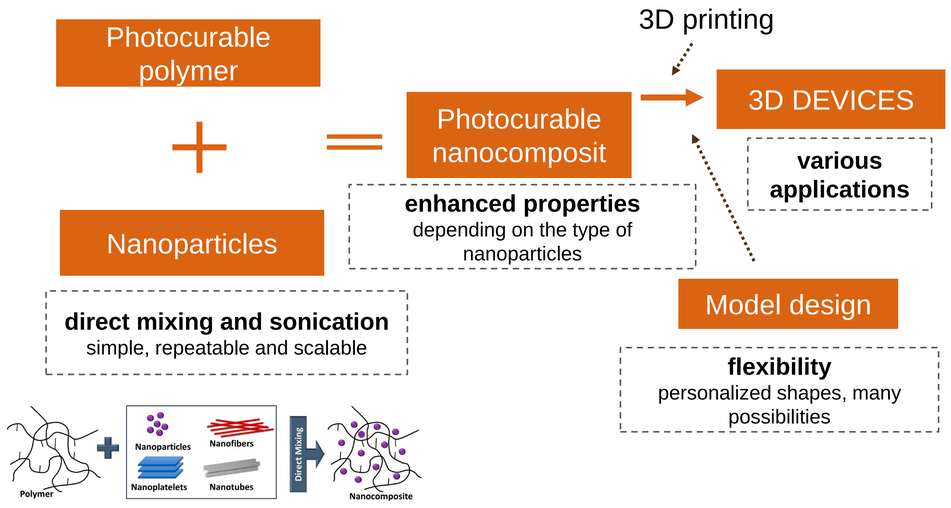
It is possible to enhance their mechanical properties by nanoparticle's doping.

Moreover, doping photopolymers with magnetic nanoparticles could facilitate local heating in AC magnetic field (magnetic hyperthermia), which find many attractive applications in medicine – such as building personalized implants, that could be heated inside living organism (and undergo self-decontamination)

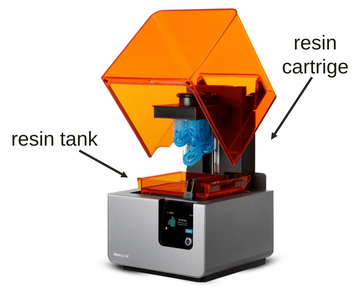


Rivas J., Kolenko Y.V., Banobre-Lopez M., Magnetic Nanocolloids, Ch. 3, 75-129, ***2016***

RESEARCH IDEA



METHODS



3D PRINTER FORMLABS FORM 2

Layer thickness: 25 – 300 microns

Laser spot: size 140 microns

Laser: 250 mW , 405 nm wavelength

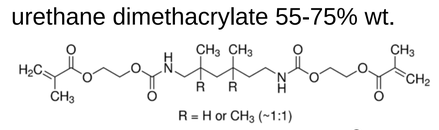
Nanoparticles:

- Iron (II,III) oxide nanopowder <50nm, Sigma Aldrich
- Barium ferrite nanopowder <100nm, Sigma Aldrich
- Titanium (IV) oxide (anatase) nanopowder <25nm, Sigma Aldrich
- Iodine pentoxide nanorods, synthsized in our laboratory

Formlabs *clear resin* ®

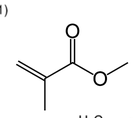
density = 1.09 g/cm^3, composition:

urethane dimethacrylate 55-75% wt.

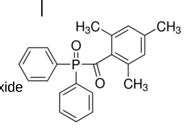


R = H or CH_3 (~1:1)

methacrylate monomer(s) 15-25% wt.



photoinitiator <0.9% wt.



Diphenyl(2,4,6- trimethylbenzoyl)phosphine oxide

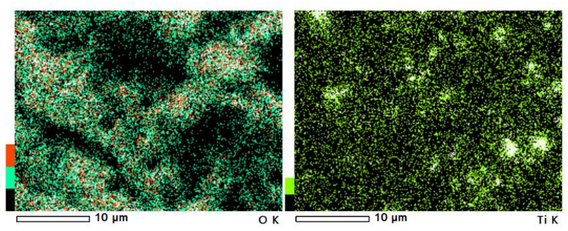
Designs

Software: Fusion 360

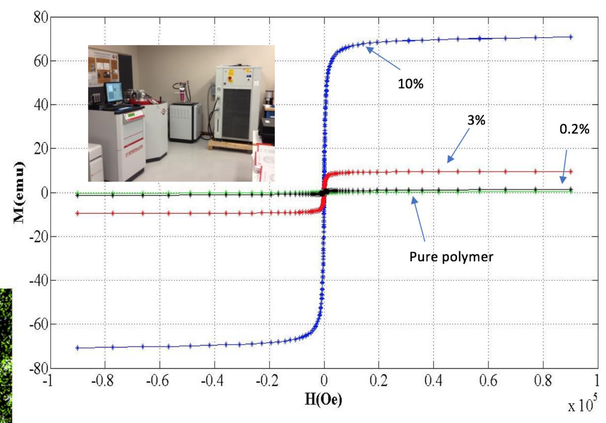
250ml of solution, concentration: 5 mg/ml

INITIAL RESULTS

Model printed from Clear resin + barium ferrite nanoparticles (concentracion 5 mg/ml)

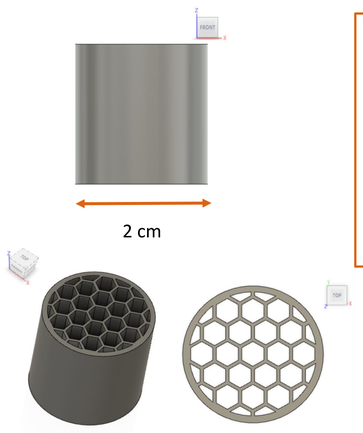


EDS map for model printed clear resin + titanium oxide nanoparticles (concentration 5 mg/ml)



Magnetization of pure liquid resin and liquid resin with Fe_3O_4 nanoparticles. Saturation magnetization for the nanocomposites was significantly higher.

FUTURE PLANS



- Testing the properties of printed objects:
  - Mechanical properties
  - Magnetic properties
- Establishing the influence of doping on resin properties.

studies on biocompatybility → designing biomedical devices