Double-layered PVP – PMVA-MA based microneedles to deliver meloxicam: An *in vitro*, *in vivo* and short-term stability evaluation study

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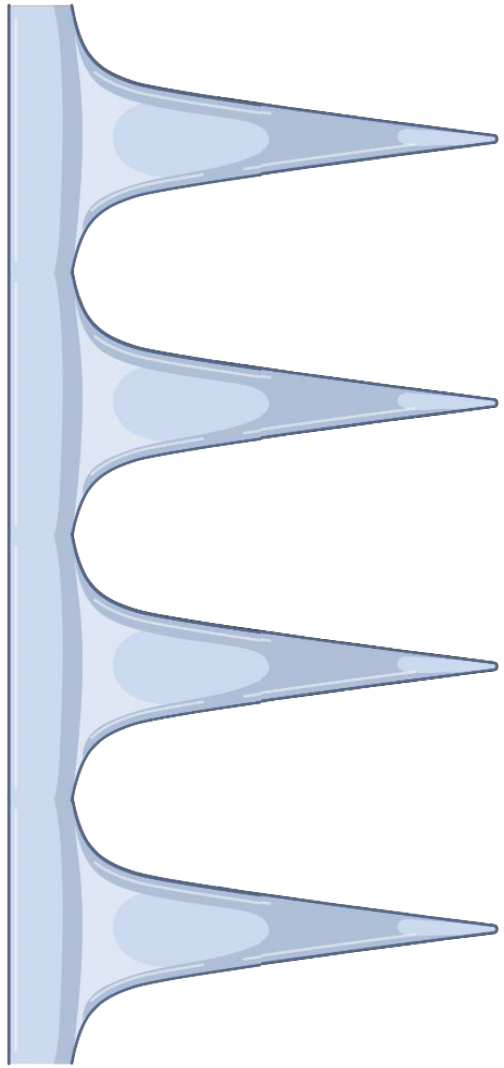
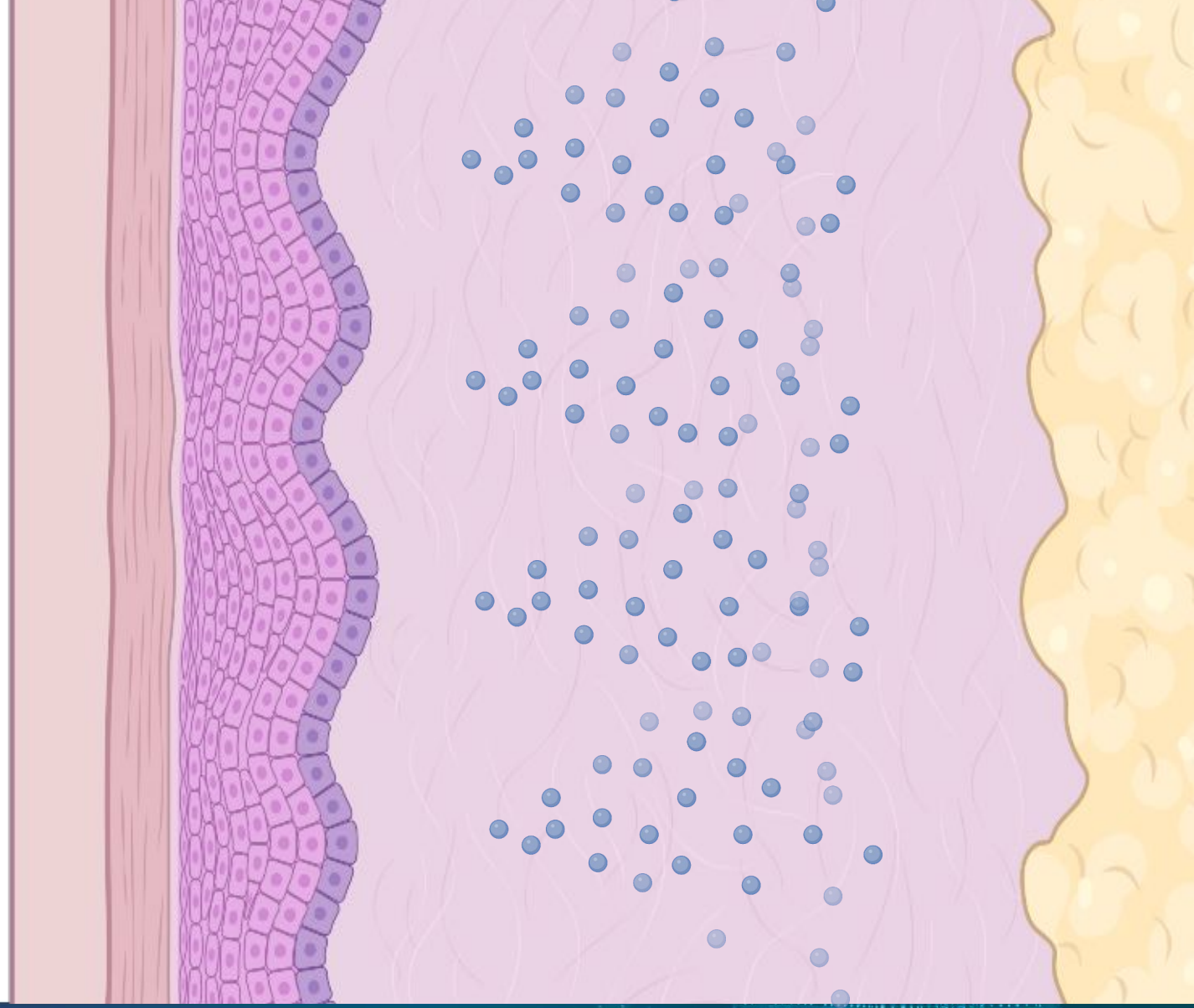
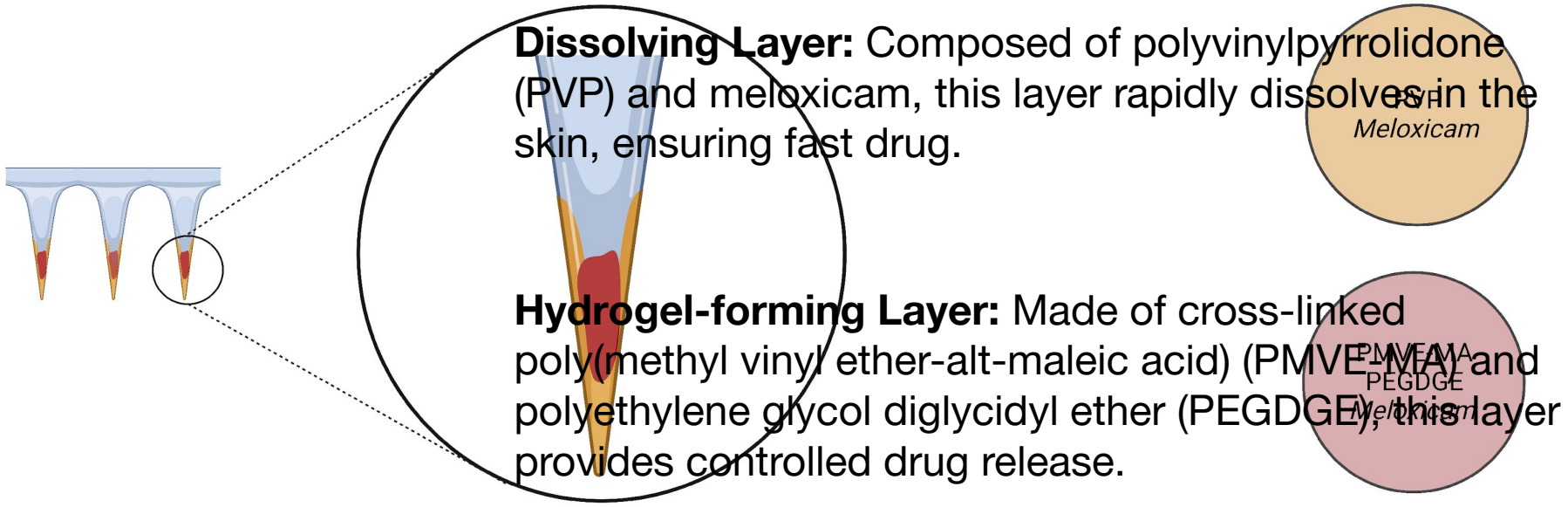
Introduction





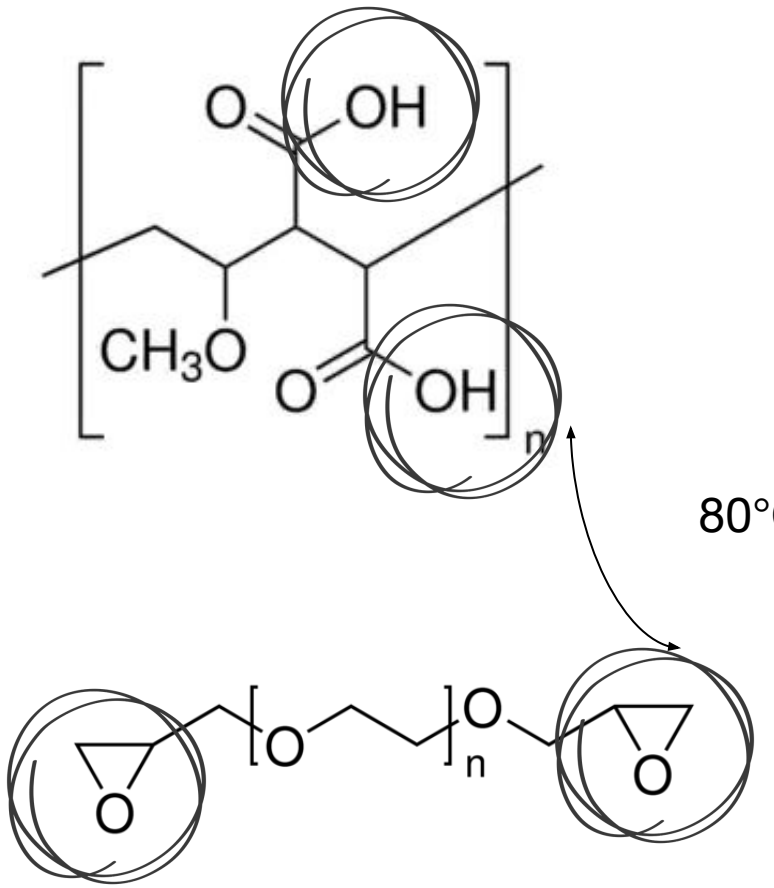
Our formulation



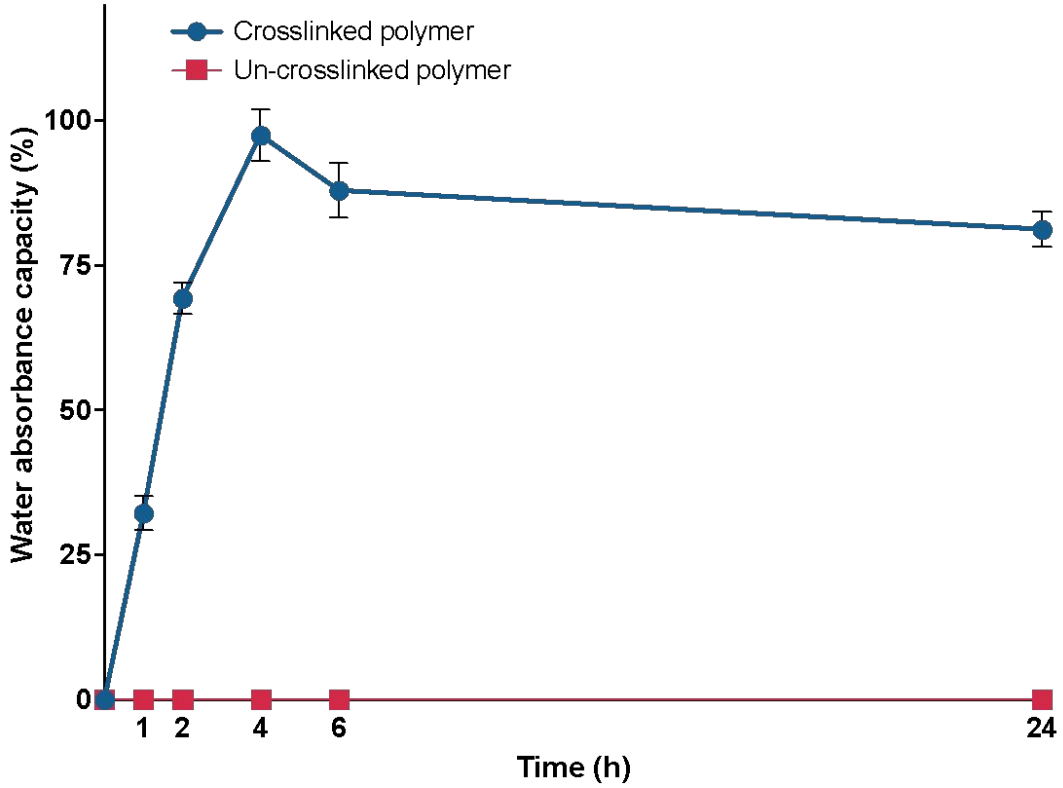
Dissolving Layer: Composed of polyvinylpyrrolidone (PVP) and meloxicam, this layer rapidly dissolves in the skin, ensuring fast drug.

Hydrogel-forming Layer: Made of cross-linked poly(methyl vinyl ether-alt-maleic acid) (PMVE-MA) and polyethylene glycol diglycidyl ether (PEGDGE), this layer provides controlled drug release.

Crosslinking reaction

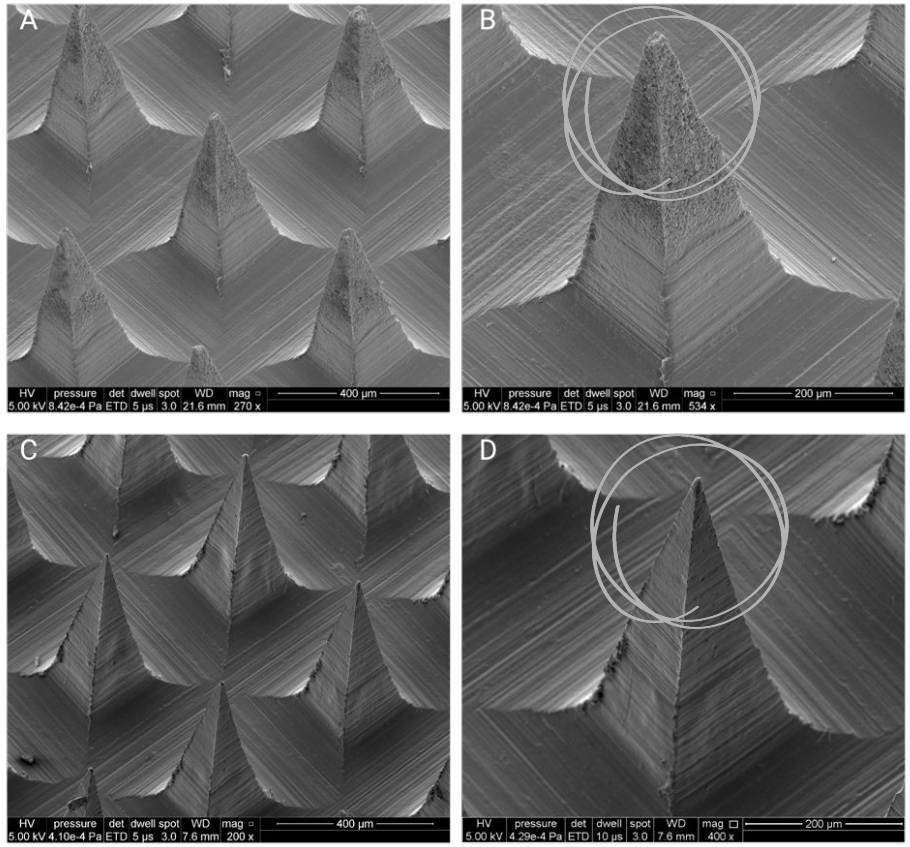


80°C / 4 hours



Morphology

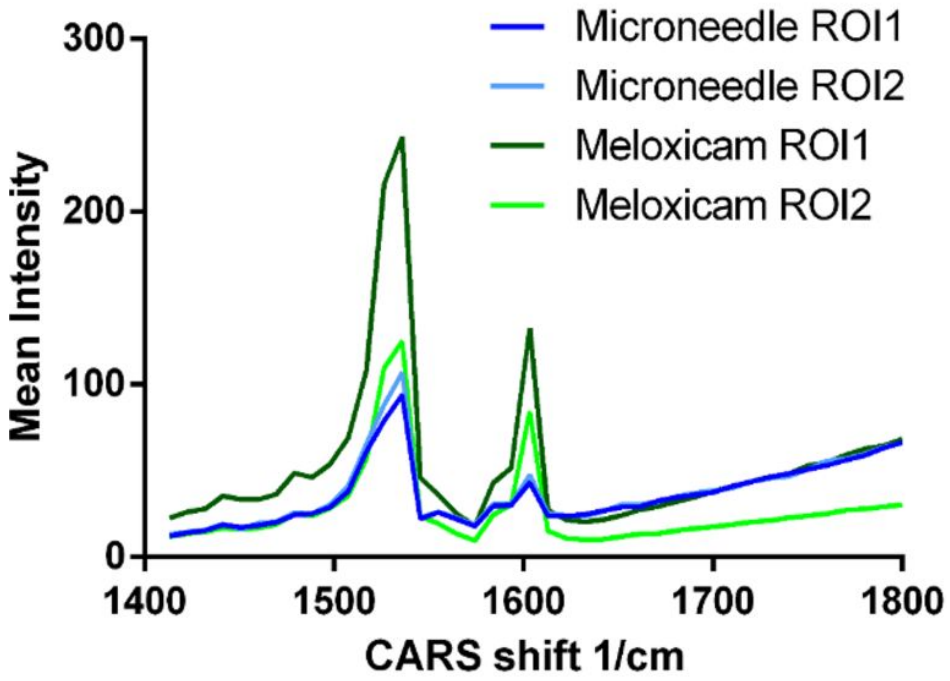
Scanning Electron Microscope (SEM)

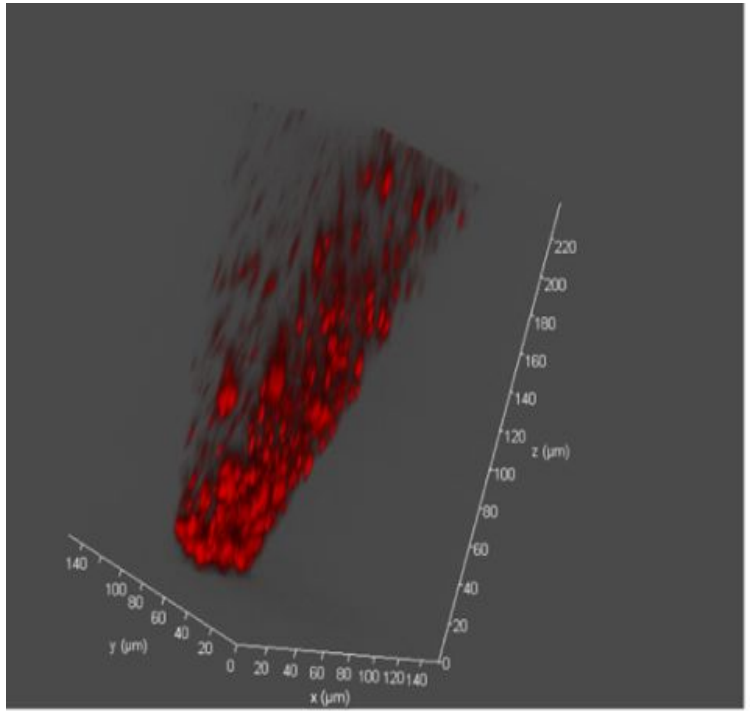


(A-B) Images of the presence of meloxicam in the form of concentrated particles at the tip of the MNs.

(C-D) Images of the smoother surface when the drug is not present in the MN-formulation.

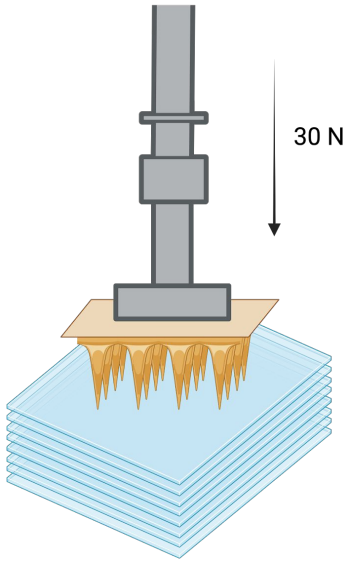
Coherent Anti-Stokes Raman Scattering (CARS)

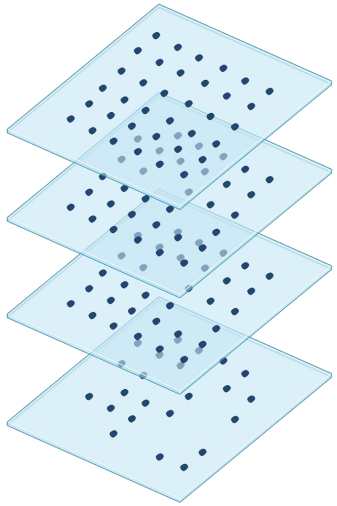


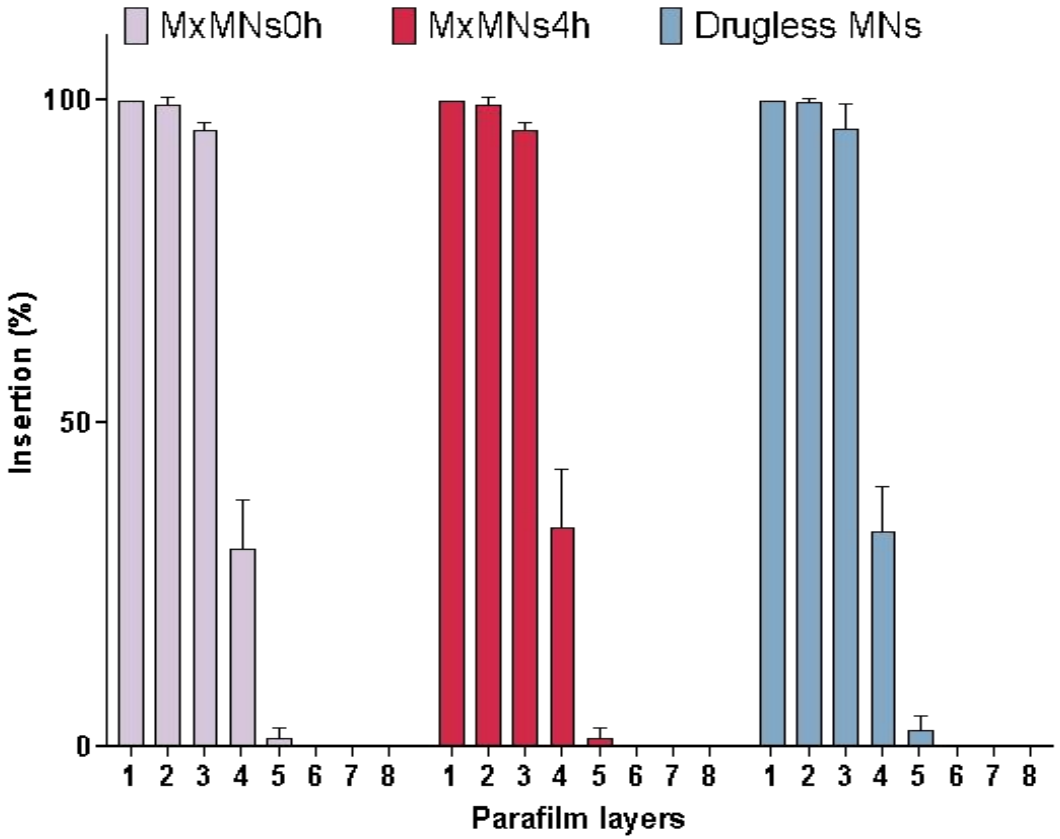


Mechanical properties

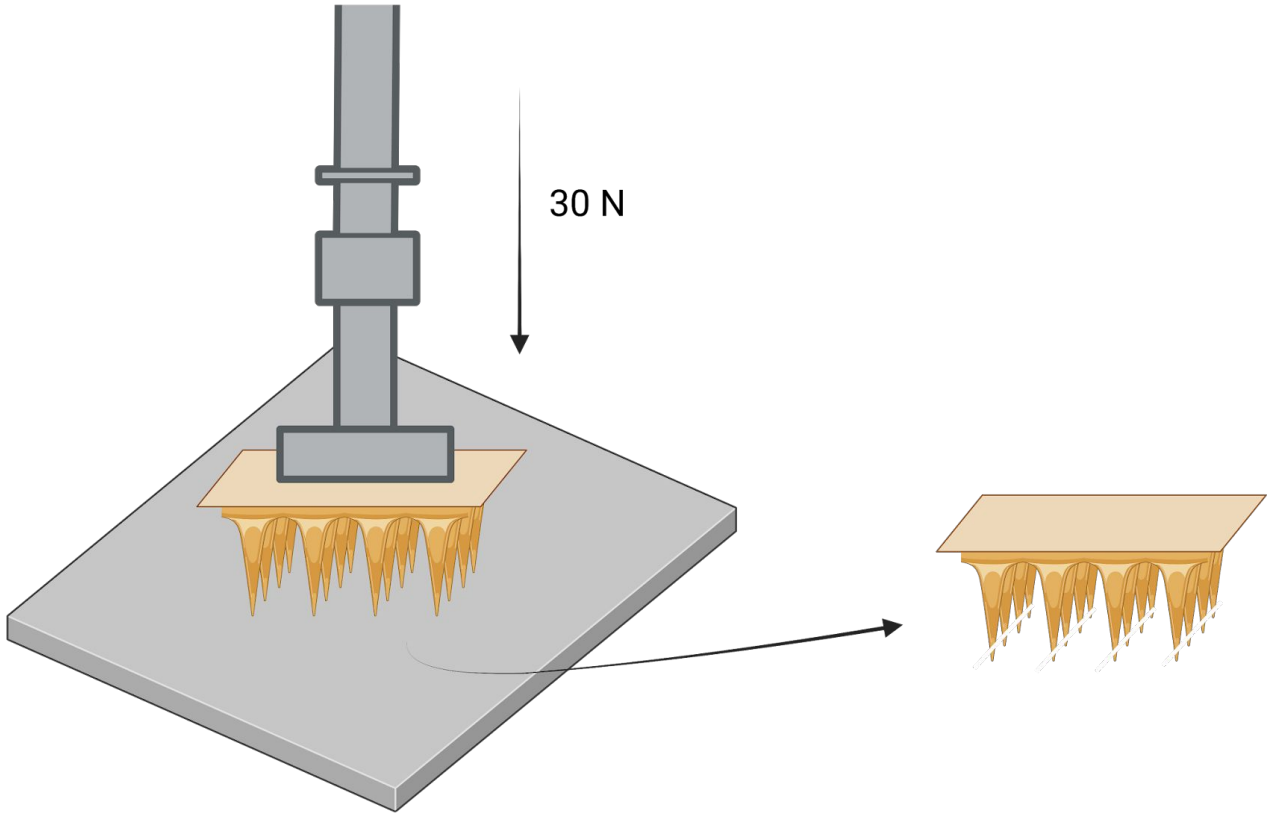
Piercing testing

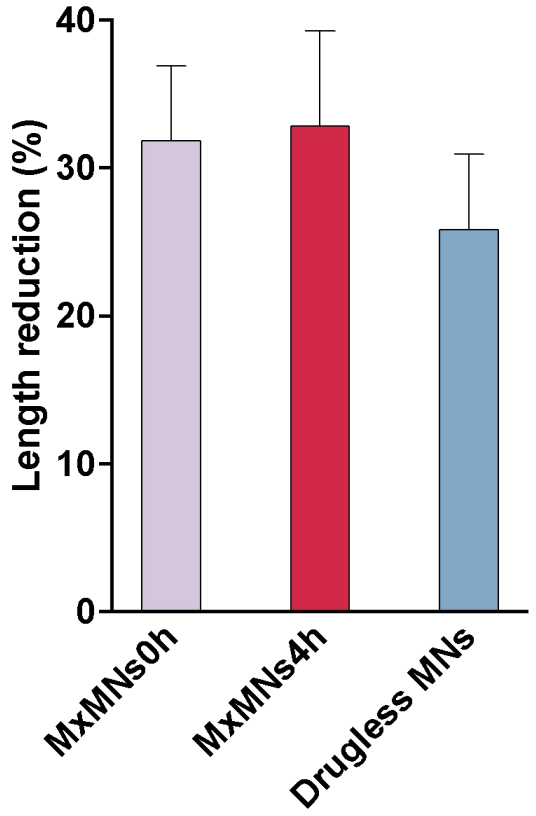






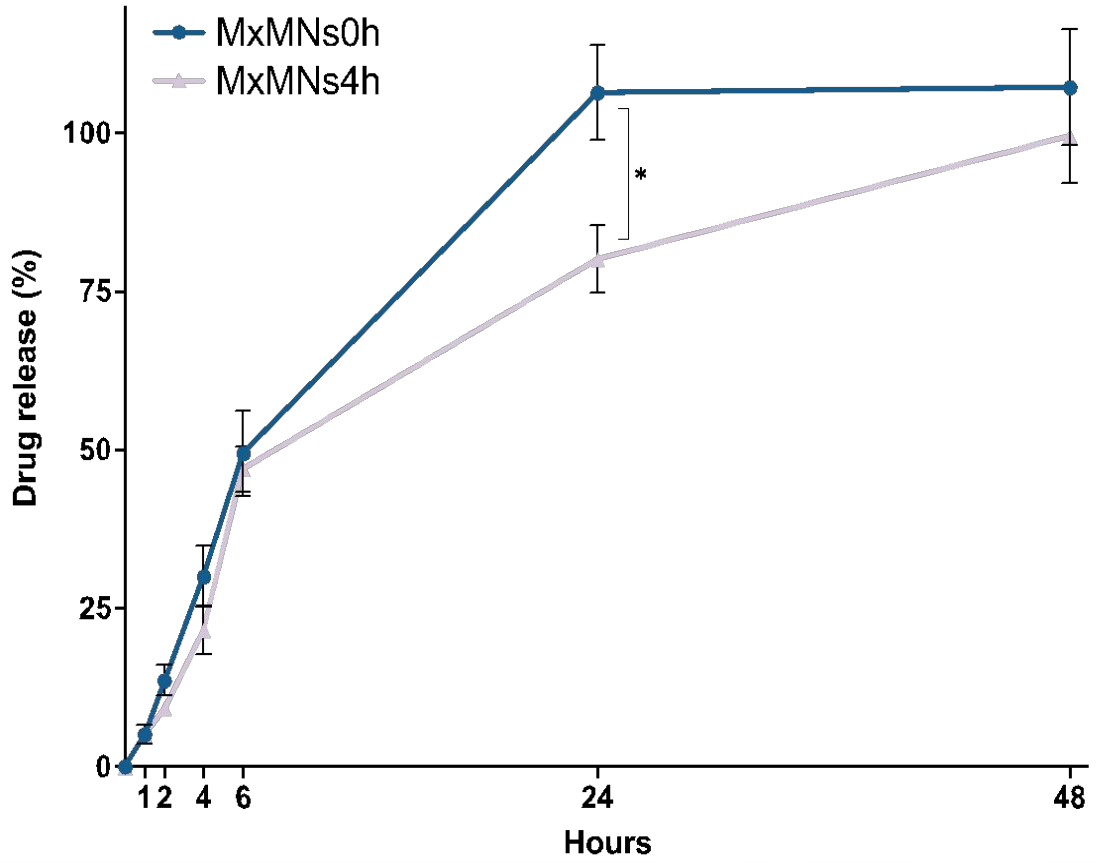
Length reduction





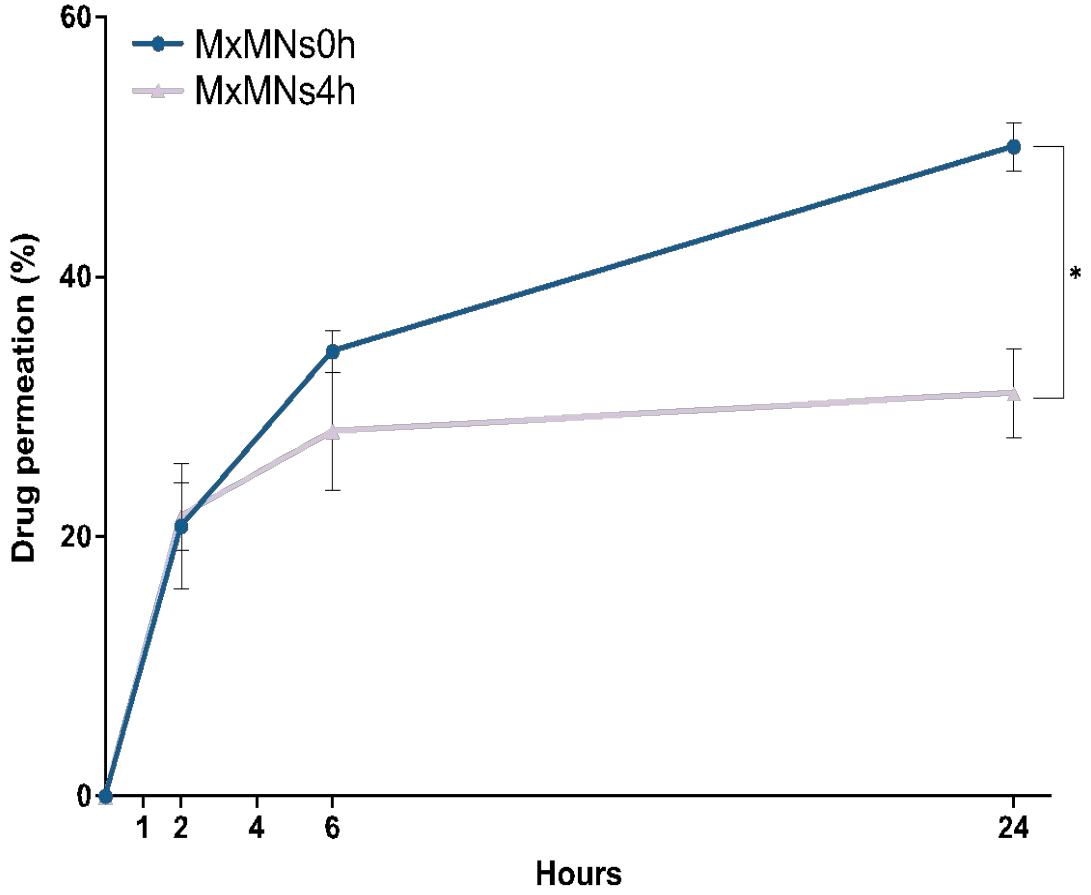
Drug delivery

In vitro studies



- Both MNs: similar 6-hour release (PVP outer layer)
- 50% drug release in initial phase
- 24 hours:
  MxMNs0h - 100% release
  MxMNs4h - 80% release

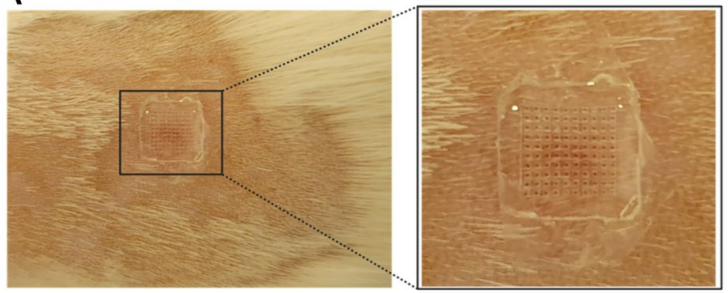
Skin permeability



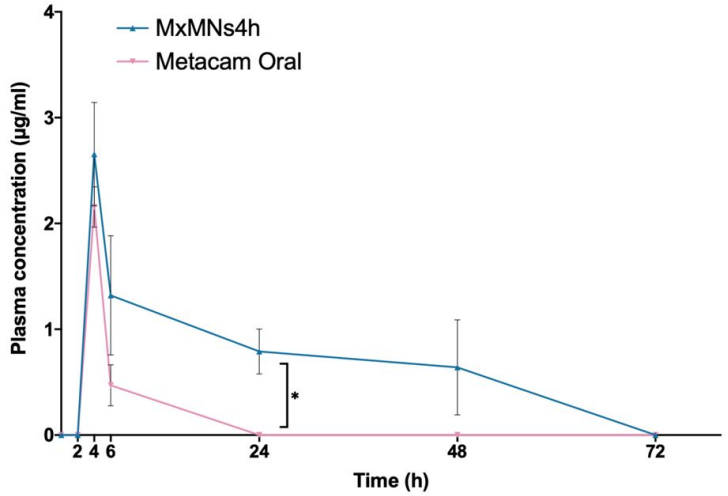
- 24 hours:
  MxMNs4h - 31% detected
  MxMNs0h - 50% detected
- MxMNs4h: better control over release

In vivo studies

A



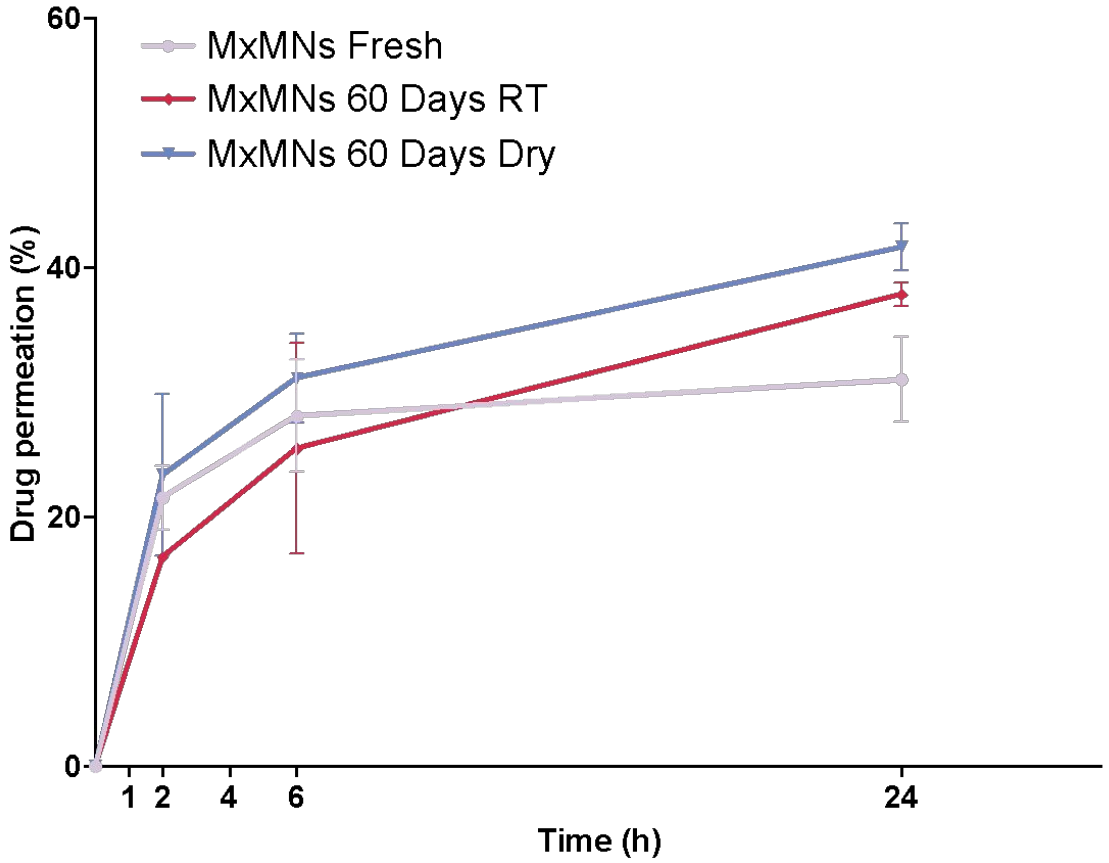
B



- MNs administered to rats
- MxMNs4h: 50 ± 10%, highest concentration at 4 h
- Oral Metacam®: <10% in our study
  48-98% in literature
- MxMNs4h:
  longer half-life than oral administration

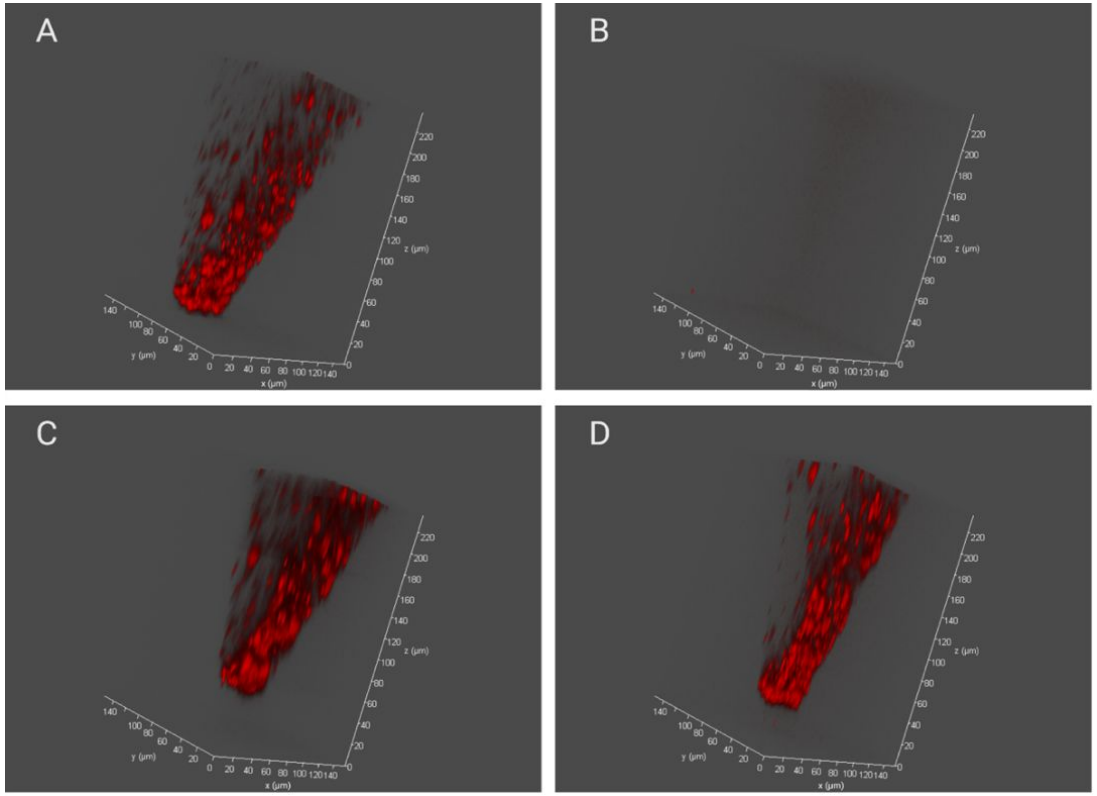
Short-term stability

Skin permeability



- Assessing short-term stability (60 days)
- Comparing fresh MNs vs. stored MNs
- No changes in drug skin permeability

Meloxicam polymorphism

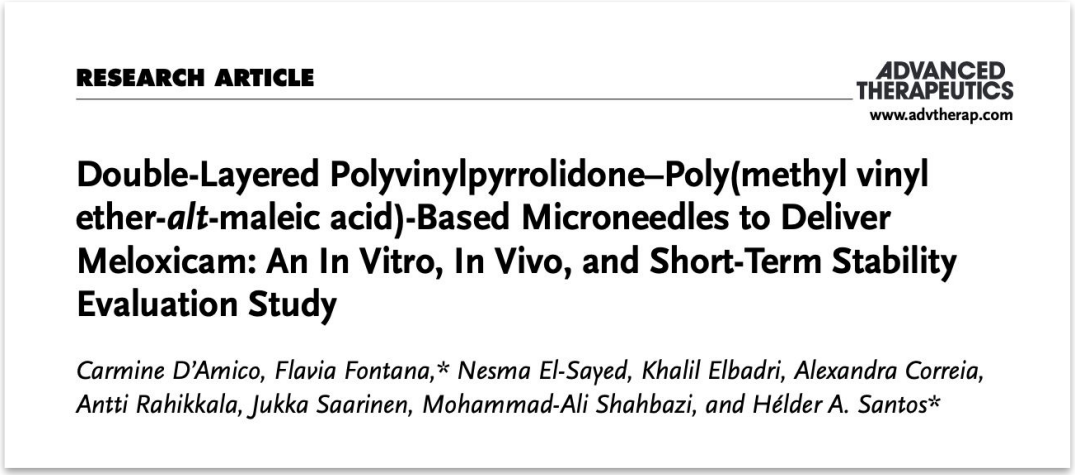


- CARS microscopy to confirm meloxicam's polymorph form

- A: Fresh MxMNs4h MNs
- B: Drugless MNs
- C: MxMNs4h (60 days, room temp)
- D: MxMNs4h (60 days, dry conditions)

Conclusions & acknowledgments

Summary



RESEARCH ARTICLE

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Double-Layered Polyvinylpyrrolidone–Poly(methyl vinyl ether-*alt*-maleic acid)-Based Microneedles to Deliver Meloxicam: An In Vitro, In Vivo, and Short-Term Stability Evaluation Study

Carmine D'Amico, Flavia Fontana, Nesma El-Sayed, Khalil Elbadri, Alexandra Correia, Antti Rahikkala, Jukka Saarinen, Mohammad-Ali Shahbazi, and Hélder A. Santos**

- Business Finland-supported study (Research-to-Business)
- Pending patent

- Double-layer MNs patch
- PVP and cross-linked PMVE-MA
- Controlled meloxicam release
- Green manufacturing process
- Unchanged meloxicam crystalline form
- Distinct release profiles (two MNs layers)
- Prolonged plasma concentration
- 60-day stability (different storage conditions)

- *Promising pain management & inflammation treatment*

Thank you for you attention

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