



# Poly(urea-formaldehyde) microcapsules for self-lubricating applications

Christos Zotiadis, Athanasios Porfyrus, Dimitrios M. Korres, Stamatina Vouyiouka\*

Laboratory of Polymer Technology School of Chemical Engineering, National Technical University of Athens, Athens, 157 80, Greece.

\*Correspondence to: Stamatina Vouyiouka (mvuyiuka@central.ntua.gr)

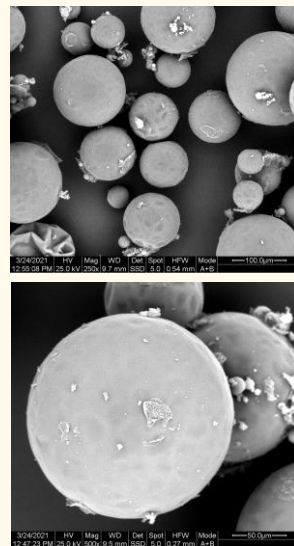
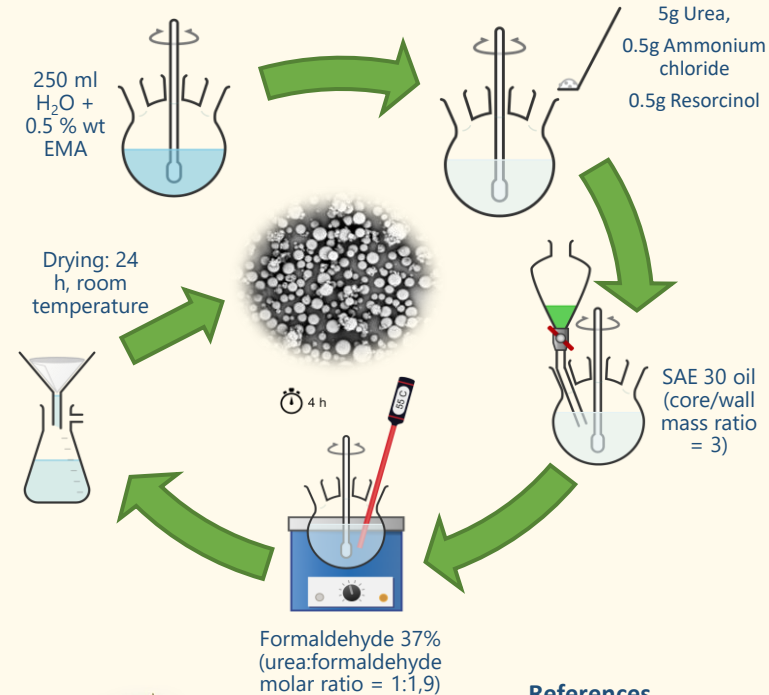


## Introduction

parts, significantly improves anti-friction properties and wear resistance. When the surface is subjected to friction, the microcapsules are ruptured and the encapsulated lubricants are released onto the surface, forming a boundary lubrication film that significantly reduces the friction coefficient and wear rate. The aim of the current work is to produce poly(urea-

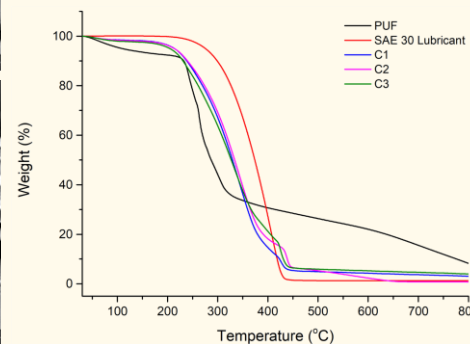
formaldehyde) microcapsules with an encapsulated lubricating oil to be used in metal coating produced *via* thermal spraying. Within the current study the stirring rate during *in situ* polymerization was examined in respect to the microcapsules characteristics.

Moving parts of all mechanical systems need to be lubricated for the efficient operation of the system. The effectiveness and stability of lubrication are crucial for improving reliability and lifetime of manufactured products, also reducing wastes of natural resources and energy. Introducing microcapsules containing lubricant into the surface of moving



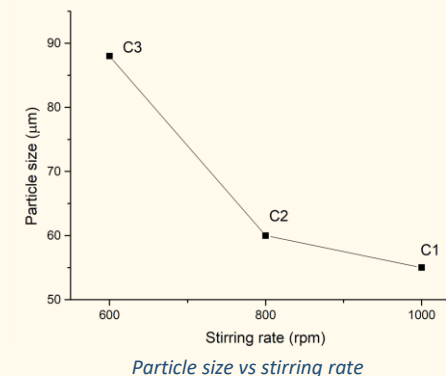
SEM images of sample C1

Sample	Stirring rate (rpm)	Encapsulation Efficiency (%)	Particle Size ( $\mu\text{m}$ )
C1	1000	79	55
C2	800	76	60
C3	600	80	88

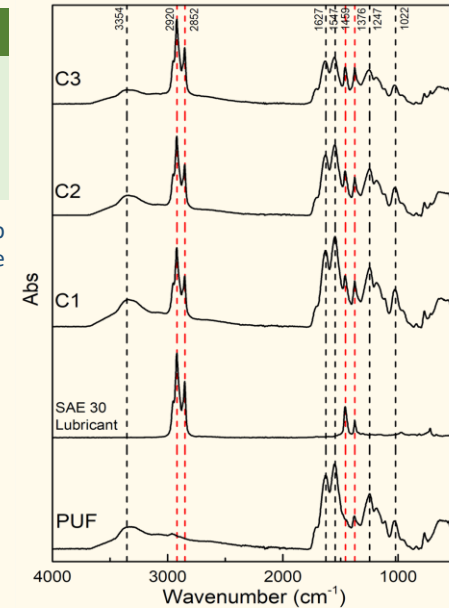


TGA curves of reference materials and microcapsules

TGA suggests thermally stable microcapsules, up to 215 °C with no significant dependence of the thermal properties on the stirring rate.



Particle size vs stirring rate



FTIR spectra of reference materials and microcapsules  
Black: peaks corresponding to PUF  
Red: peaks corresponding to lubricant

## Acknowledgement

This research has been co-financed by the European Regional Development Fund of the European Union and Greek national funds through the Operational Program Competitiveness, Entrepreneurship and Innovation, under the call RESEARCH – CREATE – INNOVATE (project code: T2EDK-01883)



European Union  
European Regional  
Development Fund



ΕΡΑΝΕΚ 2014-2020  
OPERATIONAL PROGRAMME  
COMPETITIVENESS  
ENTREPRENEURSHIP  
INNOVATION



ΕΣΠΑ  
2014-2020  
ανάπτυξη - εργασία - αλληλεγγύη  
Partnership Agreement  
2014 - 2020

Co-financed by Greece and the European Union

## References

- C. Zotiadis, I. Patrikalos, V. Loukaidou, D.M. Korres, A. Karantonis, S. Vouyiouka, Prog. Org. Coatings. 161 (2021) 106475.
- S. Tzavidi, C. Zotiadis, A. Porfyrus, D.M. Korres, S. Vouyiouka, J. Appl. Polym. Sci. 137 (2020) 1–11.
- H. Gong, C. Yu, L. Zhang, G. Xie, D. Guo, J. Luo, Compos. Part B Eng. 202 (2020) 108450.
- P.P. Gao, Z.H. Zhou, B. Yang, X. Ji, M. Pan, J.H. Tang, H. Lin, G.J. Zhong, Z.M. Li, Prog. Org. Coatings. 150 (2021).

## Conclusions

Lubricating oil was successfully encapsulated within a poly(urea-formaldehyde) shell using *in-situ* polymerization. Within the current work the stirring rate during encapsulation was studied. The results evidence that reducing the rate of agitation affects mainly the particle size, which is increased. On the other hand, the encapsulation efficiency, thermal properties and chemical structure do not present any significant variation.

