

Designing and Development of Infection Resistant Polyurethane Catheter

Manali Somani, Bhuvanesh Gupta*

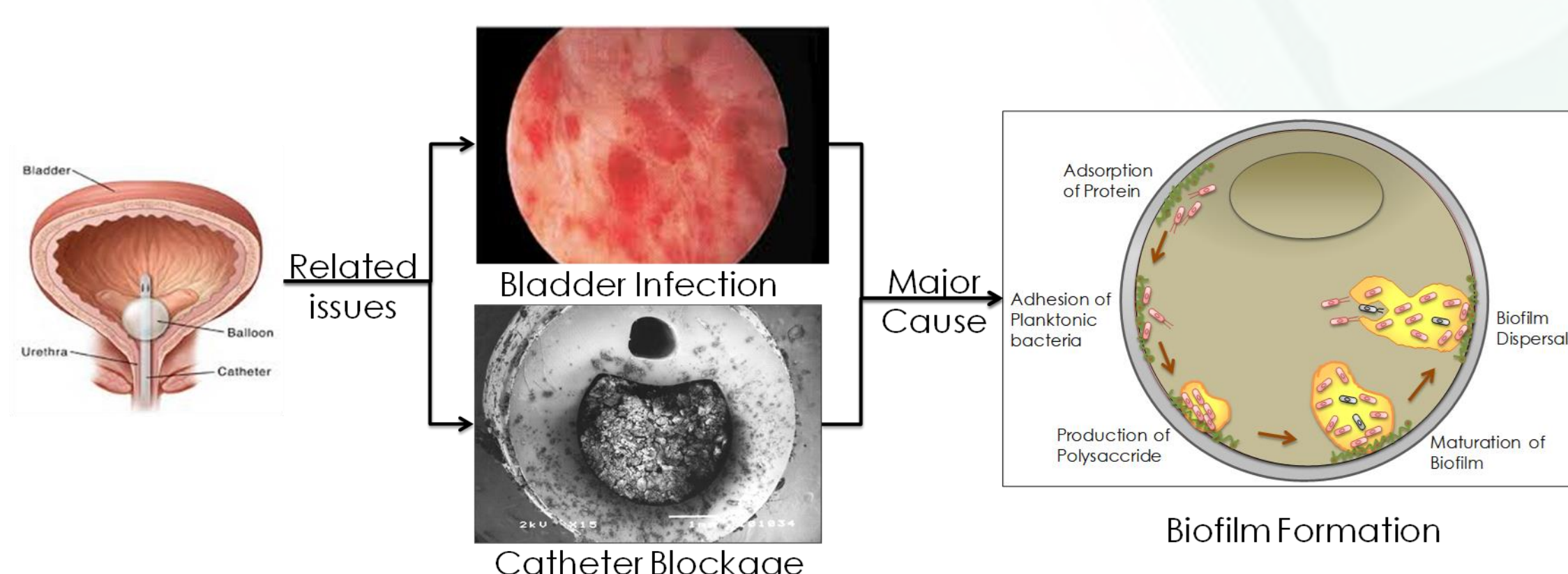
Bioengineering Laboratory, Department of Textile Technology, Indian Institute of Technology, New Delhi-110016, India
Email - manali.100mani@gmail.com

Abstract

The aim of this study involves the development of antimicrobial polyurethane (PU) catheter. PU tubes are functionalized by alkaline hydrolysis resultant amine functionality generated. Subsequently Chlorohexidine digluconate (Clx) bioactive moiety were immobilized on functionalized PU tube which introduced the antimicrobial property in the material therefore called as catheter. PU catheter shows excellent bacteriostatic and bactericidal activity against both *E. coli* and *S. aureus*.

Introduction

Urinary catheters are bestowed to get relief from urinary retention and urinary incontinence problem. However, this catheterization is accompanied by catheter-associated urinary tract infections (CAUTI) and catheter blockage. Therefore, there is a strong need to develop an antimicrobial urinary catheter which prevents the infection. Polyurethane (PU) has found enormous interest in various applications due to high strength and inert property.



Materials and Methods

Alkaline hydrolysis using NaOH is being used for the generation of hydrophilic functionality on PU surface. Reactant concentration and reaction time were investigated in terms of good hydrophilic functionality. PU functionalization was investigated using various characterization techniques i.e. FTIR, Raman, SEM, AFM analysis, mechanical analysis, and contact angle. Clx molecule was immobilized on functionalized PU surface and resultant antimicrobial PU catheter is developed. Antimicrobial studies of PU-Clx catheter were investigated against both *E. coli* and *S. aureus*.

Conclusions

- PU catheter were functionalized by alkaline hydrolysis resultant hydrophilic amine functionality is generated.
- Optimized condition, 10% NaOH concentration and 8 h of reaction time.
- Clx immobilized PU catheter shows excellent bacteriostatic and bactericidal activity against both bacteria and offer good inhibition against biofilm formation.

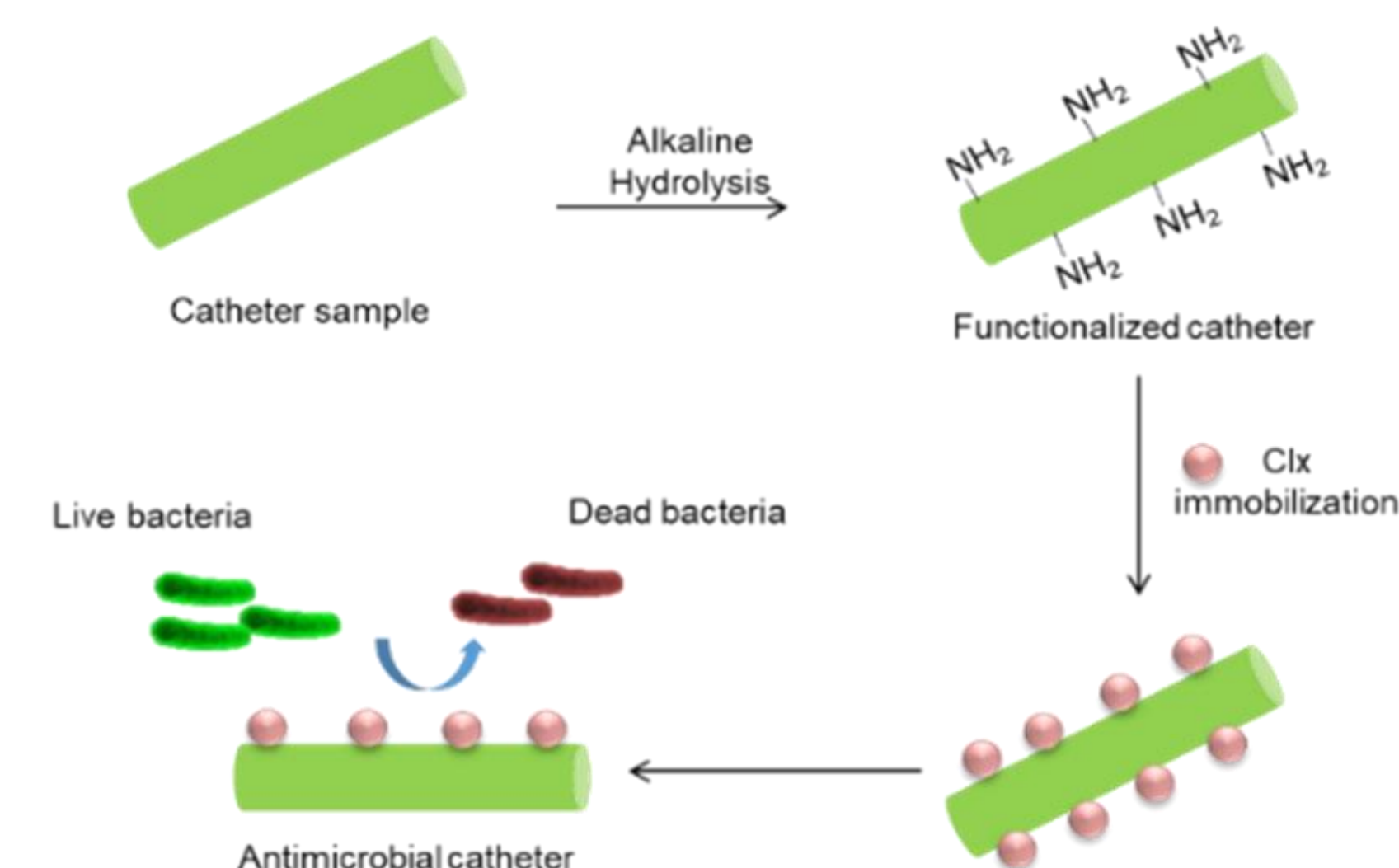
Industrial Significance

This technology is excellent for the development of infection resistant catheter undergoing surgical procedure. Industries may provide antimicrobial catheter system which is feasible and resistant to various microorganism.

Technology Readiness Level:

Patent applied and technology is ready for commercialization.

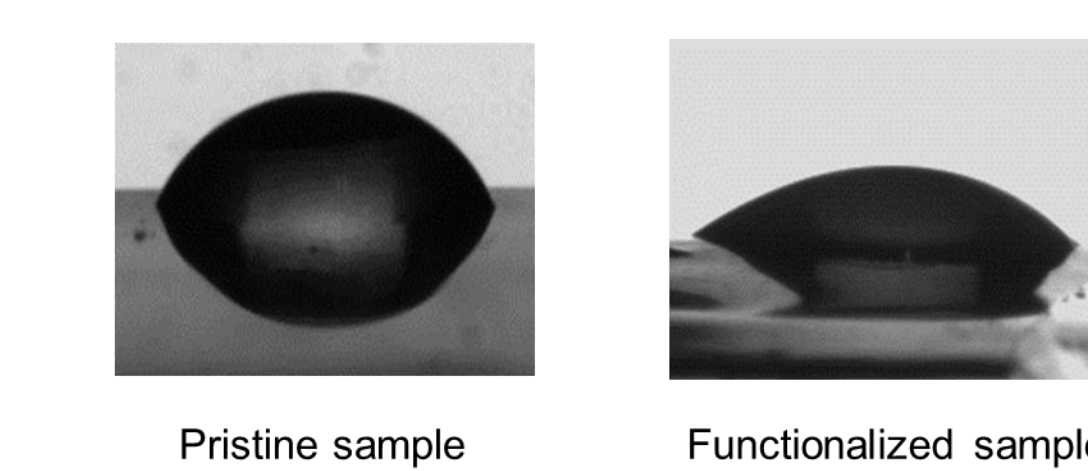
Result



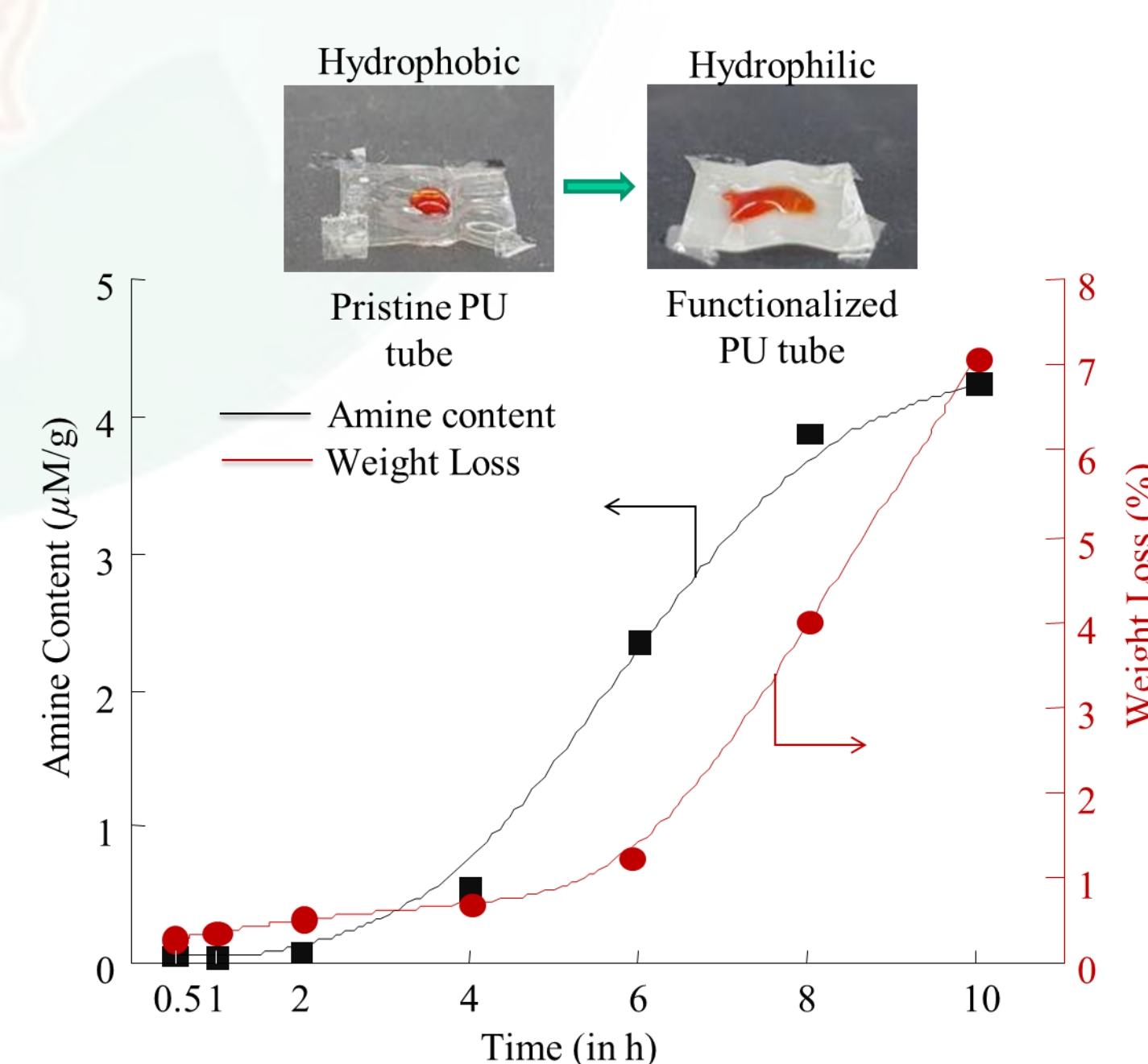
Schematic representation of functionalization of PU using alkaline hydrolysis and immobilization of drug using dip coat method



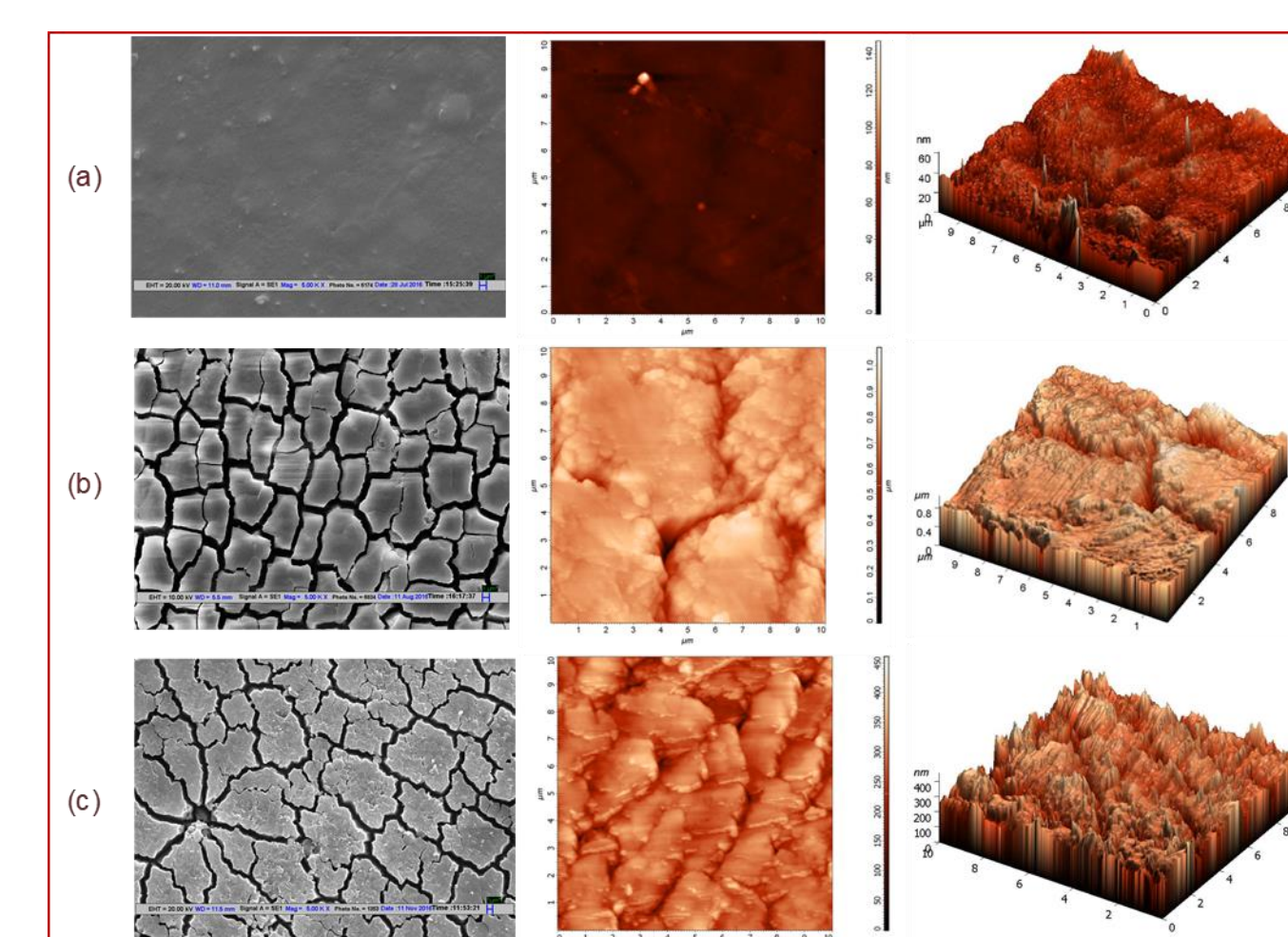
Digital images of pristine PU, functionalized PU and drug immobilized PU sample



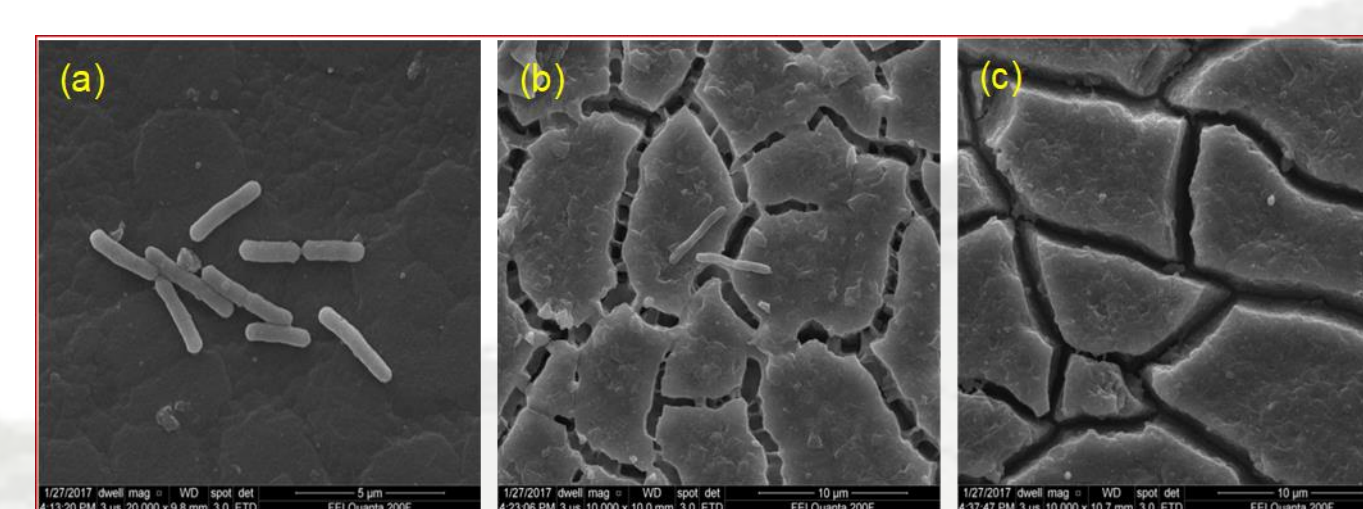
Contact angle images of pristine PU and functionalized PU sample



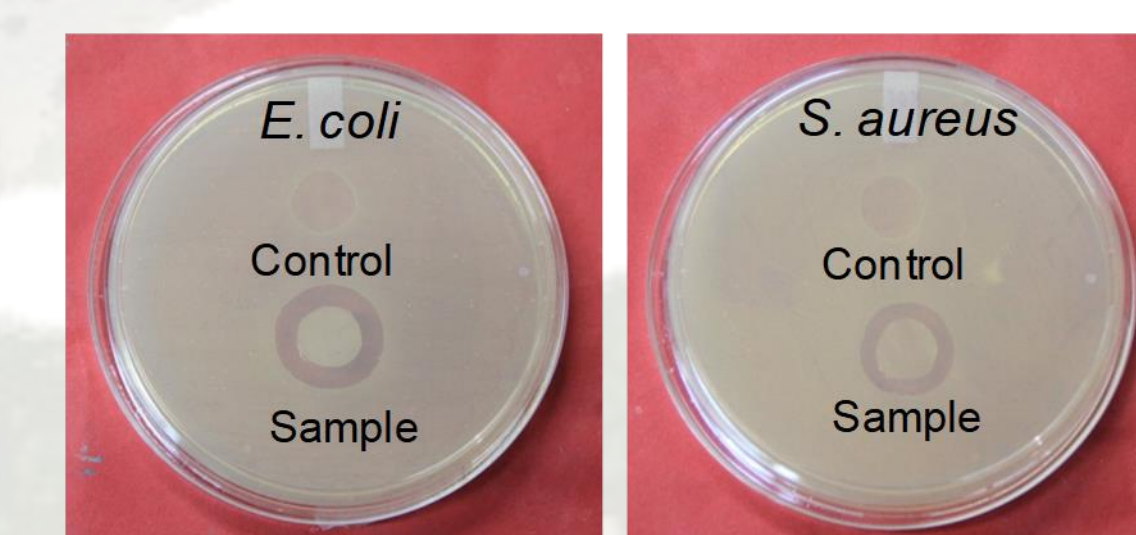
Amine content variation and weight loss study of hydrolysis functionalized PU catheter. At optimized condition, amine content found to be $\sim 4 \mu\text{M/g}$.



Surface morphology and Topography studies using SEM and AFM shows hydrolysis create pits on surface and steep hills and trough due to reformation of hydrophilic surface in the aqueous atmosphere when dipped in Clx solution. (a) Pristine PU (b) hydrolyzed PU (c) Clx immobilized sample



Bacterial Adherence studies against *E. coli*. shows no adherence on Clx immobilized catheter (a) Pristine PU (b) hydrolyse PU (c) Clx immobilise sample



Zone of inhibition studies of pristine PU and Clx immobilized PU catheter

References

1. Anjum, S., et al. (2017). *Adav. Mater. Lett.*, 8(1), 13-18.
2. Anjum, S., et al. (2016). *J. Bioactive Compat. Polym.: Biomed. Appl.*
3. Zanini, S., et al. (2015). *J. Coll. Inter. Sci.*, 451, 78.
4. Nowatzki, et al. (2012). *Acta Biomat.*, 8, 1869.
5. Agarwal, A., et al. (2012). *Biomaterials.*, 33(28), 6783-6792.

Acknowledgement

The authors thanks Department of Textile Technology for giving this platform and providing instruments and facilities for doing research. SMITA, CRF, NRF Labs for providing facilities to do the characterization.