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DEVELOPMENT OF "DESIGN-FOR-RECYCLING" FLEXIBLE POLYURETHANE FOAM

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INTRODUCTION

Polyurethane (PU) is a widely used polymer. Due to the broad range of polyols and isocyanates, multiple products can be designed. The main application is flexible foams used in mattresses or seat cushions and rigid foams used as insulation materials [1]. In recent years, the focus has shifted toward emissions during the manufacturing of PU foams. For this reason, increased emphasis is placed on non-volatile catalysts, which can be incorporated directly into the PU matrix. [2]. However, the recycling of these catalysts is much more difficult or scarcely possible. The aim is to develop a PU flexible foam with the fewest possible components, to obtain a deeper understanding of PU recycling processes. The developed foam will also be investigated with regard to mechanical properties and flammability behavior.

EXPERIMENTAL

The general procedure for the foam manufacture is as follows: 100 g polyol A, 2.16 g catalyst and 3.0 g water were mixed with a stirrer at 1200 r*min-1 for 55 s. 49 g isocyanate was then added to the mixture and stirred at 2000 r*min-1 for 10 s. The whole suspension was subsequently poured into a paperboard sleeve, in which the foam was built up and cured. The foaming parameters were recorded by FOAMAT software.

- Start time: < 11 s
- Rise time: 171.5 s
- Shrinking within 300 s: 1.6 %

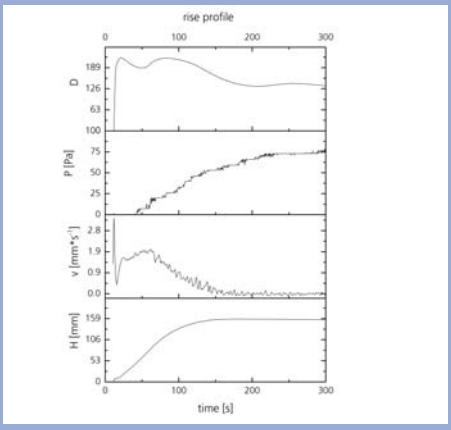

Fig 1: Rise profile of the flexible foam.

FURTHER INVESTIGATIONS

- Incorporation of renewable polyols
- Evaluation of mechanical trials
- Flammability tests
- Solvolysis of the foam: Investigation of recyclability
- Performing of LCA studies

CONCLUSION

- The development of a simplified component PU foam was successful. Further trials for suitable applications will be carried out.

ANALYSIS

The foam was investigated with TGA, IR and RAMAN measurements [4-6].

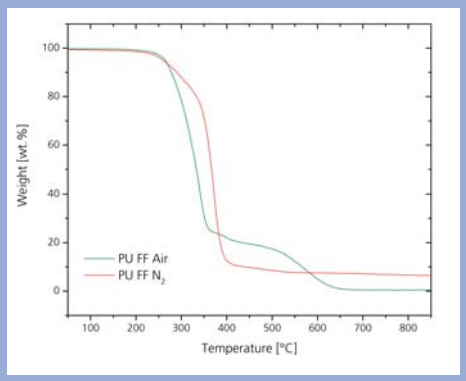

Fig 2: TG analysis of the PU foam under nitrogen and synthetic air from 25 to 900 °C.

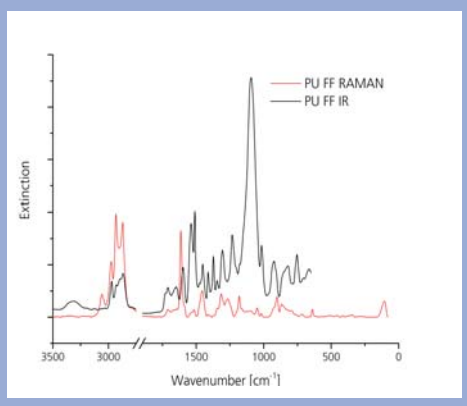

Fig 3: IR- and RAMAN spectra of the foam.

- Start of decomposition above 200 °C.
- Three-step decomposition of the foam can be observed in the TG analysis under air atmosphere
- The mass loss is around 76 % in an air atmosphere and nearly 100 % under nitrogen
- Dissociation temperatures of main bonds [3]
  - 180 – 220 °C urethane
  - 235 – 250 °C disubstitued urea

Tab 1: Infrared and raman extinction identified in foam (v: stretching, δ: bending).

Wavenumber [cm^{-1}]	Assignments
3000 – 2800	ν(CH-alkyl)
around 1445	δ(CH-alkyl)
1750	ν(C=O) of -NHCOO-
1600	ν(C=C) aromatic (IR)
1600, 938, 638	ν(C=C) aromatic (RAMAN)
around 1530	ν (NH) of -NHCOO-

Literature

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