Examination / PMS / 09ᵗʰ October 2014
PMS – Lecture Polymer Synthesis

120 minutes / please write legible / Always provide number of task !
Please label additional A4-sheets with your name and inscription number
Prof. Dr. Wolfgang Binder

Name :_____

Inscription Number :
Points total: 100
Points achieved: **Mark :**

Key : (1,0) 100-96; (1,3) 95-91; (1,7) 90-87; (2) 86-83; (2,3) 82-79; (2,7) 78-75; (3) 74-71; (3,3) 70-66; (3,7) 65-62; (4) 61-50; (5) 49-0

1) Provide the basic steps for free radical polymerization. Discuss these steps in detail for the free radical polymerization of 2-hyroxyethyl-acrylate using Fenton's reagent as initiator. (including formulas)
          (6P)

2) (a) Provide the mechanism of the anionic polymerization of isoprene using naphtaline/sodium as initiator and oxirane as terminating agent (formulas).(b) If you want to achieve a polymer with Mn = 11,500 g mol^{-1} with the polymerisation described via (a), how much monomer and initiator (in gram) do you need, if you want to generate 10 g of this polymer in a yield of 100 %, assumed that the polymerization is highly living?   **(8P)**

3) Cyclobutene is polymerized via ROMP using a Grubbs-I-Catalyst. Provide the exact mechanism of the polymerization including formulas of all intermediates as well as the endproduct, obtained by quenching of the reaction using ethylvinylether.   **(4P)**

4) Metallocene (see below) can be used to polymerize propylene and butylene.
(a) Which type of polymerization is present (name?)
(b) please outline the exact mechanism of the polymerization reaction of propylene with this catalyst using MAO as coinitiator.
(c) If pure PP is obtained, one specific form of PP is generated to ~95 %, if the **metallocene** is used. Which one ? provide the exact formula of the then generated PP and the exact mechanism of its generation (also provide a rationale)
(d) If propylene and butylene are copolymerized, the copolymerization-parameter are r$_1$ = 1,0 und r$_2$ = 0.001. Provide the chemical formula of the generated copolymer, if a starting mixture of 50 mol % propylene mit 50 mol% butylene are copolymerized after a conversion of <10 %.
          (10 P)
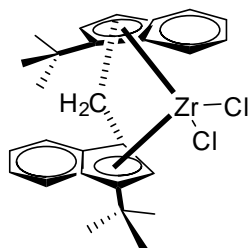
5) What is NMP ? Provide the exact mechanism of the NMP-polymerization of N,N-dimethylmethacrylamide using dibenzoylperoxide and an TEMPO.   **(4P)**

6) Describe the polymerization of 2-methyl-1,3-oxazoline using methy triflate as initiator in detail. Provide the exact structure of the polymer after quenching with diethylamine.   **(6P)**

7) Provide all exact formulas of the polymers possible generated by the polymerization of norbornene.   **(6P)**

8) Provide the exact structural formulas (chemical formulas) of Co-PS-(block)-poly(tetrahydrofurane); Co-PAN-alt-(cis-1,4-PI).   **(6P)**

9) What is ATRP ? Provide the exact reaction mechanism by polymerizing MMA via ATRP-methods using benzylbromide as initiator. Please consider all endgroups and provide all necessary reagents !   **(6P)**

10) Provide the exact chemical structure of (a) poly(2-methyl-ε-caprolactam); (b) PC; (c) PET; (d) PMMA.
Which of these polymers can be tactic ? (provide a full and complete answer for each polymer!)   **(8P)**

11) The following reaction partners are reacted within a polycondensation reaction: 12,5 mmol bisphenol A-sodium salt with 12,5 mmol bis(4-fluorophenyl)-ketone. During this reaction 24,6 mmol NaF are generated. (a) Calculate the average molecular weight (M_n) generated during this reaction? (b) What is the expected PDI ? Provide the exact chemical formula of the generated polymer.   **(6P)**

12) What is an amino-resin. Provide a chemical formula of this polymer and the possible monomers; provide a mechanism of the reaction?   **(6P)**

13) What are criteria for a living polymerization reaction. (Name at least 6! describe also the underlying graphs..)   **(6P)**

14) Which polymer is generated by the polymerization of tetrahydrofurane? Which basic organic mechanism is operating and which initiators are responsible for this polymerization?   **(6P)**

15) Give a kinetic description of ATRP (rate law). What is significantly different when comparing it to the free-radical polymerization   **(6P)**

16) Provide the components of a poly(urethane). Which main products and which side-products are possible in this reaction. How is a PU-foam produced (please explain with Formulas)   **(6P)**