LOCAL ORGANIZERS

Dr. Cornelia VASILE
Dr. Georgeta CAZACU
Dr. Diana CIOLACU
Dr. Mihai BREBU
Dr. Carmen Mihaela POPESCU
PhD student Catalina CHEABURU

Department of Physical Chemistry of Polymers
“Petru Poni” Institute of Macromolecular Chemistry
IASI, ROMANIA
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Programme
COST Action FA0904
28th - 29th June, 2010

"Petru Poni" Institute of Macromolecular Chemistry, Conference Hall, 41A Grigore Ghica Voda Alley, Ro 700487 Iasi, Romania,
Tel.: +40 232 217454 Fax: +40 232 211299 http://www.icmpp.ro

Preliminary Programme
Conference and WG meetings
COST Action FA0904
"Eco-sustainable food packaging based on polymer nanomaterials"
28-29th June 2010

Venue: “P.Poni” Institute of Macromolecular Chemistry, Conference Hall, 41A Grigore Ghica Voda Alley, Ro 700487 Iasi, Romania,
Tel.: +40 232 217454 Fax: +40 232 211299 http://www.icmpp.ro

Monday, June 28th, 2010

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<tr>
<td>8:00-9:00</td>
<td>Registration</td>
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<tr>
<td>9:00-9:40</td>
<td>Opening of the meeting&lt;br&gt;Adoption of the agenda&lt;br&gt;Local information</td>
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<td>Clara Silvestre: COST Action FA0904 Chair, Bogdan Simionescu: PPIMC Director, Rimantas Venskutonis: COST Action Rapporteur, Cornelia Vasile: CONFERENCE Chair</td>
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<tr>
<td>9:40-10:40</td>
<td>Chairperson: Cornelia VASILE&lt;br&gt;Plenary lecture: Leader WG1&lt;br&gt;Towards new safe nanomaterials for food packaging&lt;br&gt;VÄHÄ-NISSI Mika</td>
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<td>Plenary lecture: Leader WG2</td>
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COST Action FA0904: Eco-sustainable food packaging based on polymer nanomaterials
Conference and WGs meeting, 28th-29th June 2010, Iasi, Romania

**Active NanoBioComposites of Interest in Food Packaging Applications**
LAGARON Jose M., BUSOLO Maria, SANCHEZ-GARCIA Maria D., LOPEZ-RUBIO Amparo, OCIO Maria J.

10:40-11:00 Coffe Break

11:00-12:45 Working Group 1
Chairperson Vähä-Nissi MIKA

*The preparation and exploitation of safe nanoparticles in polymer films for food packaging.*
MITCHELL Geoffrey R., DAVIS J. Fred.

*The role of bacterial biofilm and oxidizing enzymes in biodegradation of plastics*
SIVAN Alex, SANTO Mira, GILAN-OR, Irit, YANIV Moshe

*Nano- and microsized starch derivatives and their applications*
RUTKAITE Ramune, BENDORAITIENE Joana, KLIMAVICIUTE Rima, ZEMAITA ITIS Algirdas

**Working Group 2**
Chairperson: Jose Maria LAGARON CABELLO

**Tailoring of polymeric materials at the nanoscale for sustainable packaging**
CHRISTOPHER Plummer, YVES Leterrier, JAN-ANDERS E Månson

*Influence of organically modified montmorillonite on processing and mechanical properties of polycarbonate*
KOZLOWSKI Marek, FRACKOWIAK Stanislaw

*New systems based on LDPE/chitosan/mmt for active packaging*
DARIE Raluca Nicoleta, CHEABURU Catalina Natalia, VASILE Cornelia

*Bio-hybrid nanocomposite packaging materials from polysaccharides and nanoclay*
VARTIAINEN Jari, TUOMINEN Mikko, NÄTTINEN Kalle, TAMMELIN Tekla, PERE Jaakko, TAPPER Unto, HARLIN Ali

12:45 13:50 Lunch
13:50-14.30 Institute Visit
14:30-15:30 Visit to Botanical Garden

15:30-17:30 Poster Session

- **Biocidal starch derivatives**: ZEMAITA ITIS Algirdas, SARKINAS Antanas, BENDORAITIENE Joana, KLIMAVICIUTE Rima
<table>
<thead>
<tr>
<th>Title</th>
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<tbody>
<tr>
<td>Potential use of the lignin in polymer films for food packaging applications</td>
<td>CAZACU Georgeta, DARIE Raluca Nicoleta, VASILE Cornelia</td>
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<tr>
<td>Sustainability and life cycle assessment for food packaging applying polymer nanomaterials</td>
<td>PIHKOLA Hanna, HOHENTHAL Catharina, VĂHĂ-NISSI Mika</td>
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<tr>
<td>Development of bioactive packaging - Eureka project E! 4952 BIOPACKAGING. CONSTANTINESCU Doina, AVADANEI Lidia.</td>
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<td>Film based on ethylene-vinyl acetate copolymer/montmorillonites nanocomposites for development of the active packaging materials</td>
<td>BAICAN Mihaela, OPREA Ana Maria, CRIVOI Florina, VASILE Cornelia.</td>
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<td>Chitosan/ polyvinyl alcohol blends for active food packaging. PAPARITĂ Elena, CHEABURU Catalina Natalia, VASILE Cornelia</td>
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<td>Isolation of Bacillus megaterium strains for PHA production</td>
<td>STOICA Irina, BAHRI Mădălina</td>
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<td>Investigation of properties of plasma polymers deposited by rf magnetron sputtering of nylon</td>
<td>ARTEMENKO A., CHOUKOUROV A., GORDEEV I., KOUSAL J., KYLIAN O., POLONSKYI O., SLAVINSKA D., BIEDERMAN H.</td>
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<td>Shear-Induced Crystallization of Isotactic Polypropylene(iPP) based Nanocomposites with Montmorillonite (MMT), DURACCIO Donatella, PEZZUTO Marilena, SILVESTRE Clara, CIMMINO Sossio, MITCHELL R. Geoffrey</td>
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<td>Characterization of mLLDPE/LDPE blends obtained by blow-molding</td>
<td>DURACCIO Donatella, MAURIELLO Amalia, PEZZUTO Marilena, SILVESTRE Clara, CIMMINO Sossio</td>
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<tr>
<td>Silica/Acrylate And Silica/Epoxy Hybrid Materials Through The Sol Gel Method. SILVESTRI B., COSTANTINI A., LUCIANI G., TESCIONE F., BRANDA F. SILVESTRI Brigida</td>
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<tr>
<td>Microbial aspects of Eco-sustainable food packaging. NIELSEN Per Væggemose</td>
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19:00-22:00 Joint Dinner

Tuesday, June 29th, 2010

9:00-10:00 Chairperson Valeria HARABAGIU
Plenary lecture: Leader WG 3  
*Current state of knowledge in regard to interaction of PNFP with packaged food products*

CHAUDHRY QASIM

Plenary lecture: Leader WG 4  
*Some Environmental Aspects of Polymers, Old and New*

G. HUNT

<table>
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<tr>
<th>Time</th>
<th>Session</th>
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<tr>
<td>10.00-11:15</td>
<td>Working Group 3 and 4</td>
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<tr>
<td></td>
<td>Chairperson: Chaudhry QASIM</td>
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</table>
|            | Carbon based nanomaterials suitable for detection of bacteria and biofilms on the surface of Plastic films  
*MOORE Edward, BLAU J Werner, BABU Ramesh*  
*Biodegradable nanocomposites for packaging and protection of consumer goods.*  
*MERIJS MERI Remo, ZICANS Janis, SVINKA Visvalidist*  
*Zinc Oxide in Polymeric Matrices: Synthesis of the Sub-Micronic Powders, Processing and Anti-microbial Activity of the Composites*  
*DEXPERT-GHYSS Jeannette, DROVAL Guillaume, VERELST Marc, ROSSIGNOL Cécile*  
*Electrospun EVOH fibres reinforced with bacterial cellulose nanowhiskers with potential in food packaging applications*  
*MARTINEZ-SANZ Marta, OLSSON Richard, LOPEZ-RUBIO Amparía, LAGARON Jose María*  
*NanoPack – a Danish research project on bio-nanocomposites for meat packaging*  
*PLACKETT David* |
| 11:15-11:40| Coffee break                                |
| 11:40-12:00| Napolynet  European Open Laboratory:  Experimental Mechanics of Micro & Nanomaterials  
*KOTSILKOVA Rumiana* |
| 12:00-13:30| Parallel Meetings of the 4 Working Groups   |
| 13:30-14:45| Lunch                                       |
| 14:45-16:30| Round table dedicated to Industry  
*Moderators*: Rumiana Kotsilkova and Doina Constantinescu |
COST Action FA0904: Eco-sustainable food packaging based on polymer nanomaterials
Conference and WGs meeting, 28th-29th June 2010, Iasi, Romania

| 16:30-17:30 | WG Meeting Reports by WG leaders |
| 17:30– 17:45 | Conclusions  
Clara Silvestre |

ROMANIAN ACADEMY
“PETRU PONI” INSTITUTE OF MACROMOLECULAR CHEMISTRY

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700487 Iasi, Romania
Tel.: +40-232-217454; *260332, *260333, *260334
Fax: +40-232-211299; e-mail: pponi@icmpp.ro

- Basic research in polymer chemistry and physics, macromolecular materials science
- Applied research. Technological transfer. Small scale production
- Didactic activity – doctoral and postdoctoral specialization
- Consulting
- Services

The “Petru Poni” Institute of Macromolecular Chemistry is an Institute of excellence of the Romanian Academy. Established in February 1949, the Institute has a long tradition of over fifty years in fundamental and applied research in the field of organic and inorganic chemistry, polymer chemistry and physics.

Located in Copou Hills and extended on an area of ten thousand square meters (laboratories of synthesis and physico–chemical analysis, conference hall, library, production units, mechanical and electrical workrooms), with a research team whose achievements (papers, patents, participation at national and international meetings, technologies elaborated and implemented in industry) are recognized in Romania and abroad, the Institute is for many years in the first line of the Romanian research and covers practically the whole area of macromolecular compounds science and technology,
as well as of polymeric materials. Our portfolio contains more than 1000 scientific papers published in
the last ten years (most of them in international journals) and over 100 projects achieved in
cooperation with partners from abroad. National contracts: External Contracts:

Useful Local Information

IASI

Iasi is the capital of Moldavia, one of the most interesting regions of Romania, a land with
mature traditions and a culture containing the root of CUCUTENI, almost 6000 years ago.
Today the Moldavian universe is a synthesis of Romanian’s history, always open to the great
cultures of the world and adapting in time, their rich influences inside the Moldavian art and
spiritual life. The traditional Moldavian style is remarkably integrated in the architectures of
our famous churches and monasteries, small in size but rich in frescoes including spiritual and
ethical connotations in each detail.

Over the past, history, culture and religious life have molded the city's unique character. Iasi
boasts an impressive number of Orthodox churches, almost 100, most of them located in the
so-called Golden Plateau. The oldest, the Princely Saint Nicholas Church, dates from the
reign of Stephen the Great (Stefan cel Mare, 1457-1504). The finest, however, are the 17th
century St. Paraschiva Metropolitan Cathedral and Trei Ierarhi Church, the last a curious
example of Byzantine art, erected in 1635-1639 by Vasile Lupu. Its outer walls and twin
towers are intricately carved in what many think of as stone lace.

The city prides itself with publishing the first Romanian newspaper and establishing the first
Romanian university. Today, Iasi is home of five universities.
PLACES TO VISIT
**Palace of Culture (Palatul Culturii)**

**Address:** Piata Stefan cel Mare si Sfant 1

**Museum under construction**

This remarkable construction (1906-1925), built in flamboyant neogothic style, stands partly on the ruins of a medieval royal court mentioned in documents dating from 1434. Today, the 365-room palace houses the Gheorghe Asachi Library and four of the city's museums: the **Moldavian History Museum**, the **Ethnographic Museum**, the **Museum of Art** and the **Museum of Science and Technology**.
St. Paraschiva Metropolitan Cathedral (Catedrala Mitropolitana Sfanta Paraschiva)
Address: Blvd. Stefan cel Mare si Sfant 46
Open: Mon. - Sun. 9:00am - 8:00pm
Free admission

Built in Italian Renaissance style, the St. Paraschiva Metropolitan Cathedral is the largest Orthodox church in Romania. Construction began in 1833 and ended in 1839, but its cupolas fell and the church remained in ruins until 1880, when, with the help of the Foundation of King Carol I, work started again, lasting until 1888. The vast interior was painted in 1887 by Gheorghe Tattarescu and the stained glass windows were completed by a Bavarian factory in Munich. In 1639, Vasile Lupu spent Moldavia's budget for the following year and a half to acquire the relics of St. Paraschiva from Constantinopole. The relics were moved to the Metropolitan Cathedral in 1889 after a fire damaged the Trei Ierarchi Church where they had originally been placed. The cathedral still uses one of the original bells in its northeast spire. Inside the bell, an inscription says it was made from four cannons captured from the Turkish army in the War of 1828-1829. Nearby stands the 18th century Old Metropolitan Church of St. George (Biserica Sfantul Gheorghe).
Every October 14, pilgrims from all corners of Romania and neighboring countries flock to Iasi to kneel before the blue and gold bier containing the relics of Saint Paraschiva, the patron saint of the cathedral.

Church of the Three Hierarchs (Biserica Sfantilor Trei Ierarhi)
Address: Str. Stefan cel Mare 62
Open: Daily 9:00am - 1:00pm & 3:00pm - 7:00pm
Admission charge

The Church of the Three Hierarchs (constructed 1637 - 1639) is highlighted as a must-see in every guidebook. Nothing can prepare you, though, for its stunning ornate decoration: the entire exterior of the church is covered in delicate and intricate patterns sculpted into the stone
and spread over 30 friezes. This "stone embroidery" is a mixture of western gothic, Renaissance and Oriental motifs.
Legend has it that the exterior was covered in gold, silver and lapis lazuli but centuries ago, when the Ottoman Empire tried to conquer Moldavia, the invaders sat the church on fire and melted all the gold. The original interior paintings were completed by Russian artists sent to Iasi by the Tsar. In 1882, the frescoes were removed when French architect Lecomte de Nouy set about redesigning the interior after several fires and six earthquakes damaged the structure. Original fragments of the frescoes are still preserved in the nearby Gothic Hall museum (Open: Tue.-Sun. 10am - 4pm. Admission charge).
The interior boasts the tombs of a number of famous Romanians, including the founder of this church, Vasile Lupu, Prince Alexandru Ioan Cuza, and Prince Dimitrie Cantemir. In 1994, the church reopened as a monastery. The three patron saints (Basil the Great, Gregory of Nazianzus and John Crysostom) are celebrated here on January 30.

Roznoveanu Palace/City Hall (Palatul Rozvoneanu/Primaria)
Address: Blvd. Stefan cel Mare si Sfant 45
This neoclassical Viennese-style palace was built in 1832 to the design of Gustav Frey Wald. Its façade was decorated with marble statues of mythological characters such as Diana and Apollo and it was said to be grander than all other mansions in Iasi. The palace burned down in 1844 and was rebuilt by Nicolae Rosetti Rozvaneanu. In 1891, the building became the City Hall but two years later, was transformed into a royal residence. Today, it once again serves as the City Hall.
Built in 1815 by Alexandru Bals, this house became the venue of choice for theatre performances in Iasi. On January 18, 1847, the famous composer, Franz Liszt, played here. In 1868, Monsignor Salandarie founded the Catholic Institute here, enlarging the building and adding a spacious extension, which today, houses the Moldavia Philharmonic. The old building is home to the George Enescu Conservatoire.

Alexandru Bals House/ Moldova

Philharmonic House (Filarmonica Moldova)
Address: Str. Arcu 13

Built in the late 19th century on the site of the old City Hall, this is one of the most elegant buildings in Romania. The architects were the Viennese Feller and Helmer who later built theatres in Cernauti and Sofia. Richly decorated in French-eclectic style, the theatre has one of the most splendid auditoriums in the country. It can seat 1,000 people and the acoustics are excellent. The theatre bears the name of the company's founder, Vasile Alecsandri (1821-1890), a renowned Romanian poet, playwright, politician and diplomat. In 1934, Greta Garbo spent some time here in secret during her love affair with John Gilbert.

National Theatre (Teatrul National Vasile Alecsandri)
Address: Str. Agatha Barsescu 18
Commissioned by Ioan Cantacuzino between 1760 and 1765, the Old University Palace was badly damaged during a fire in 1795. Later renovated and converted into a royal residence, it remained in royal use until 1806. The stone arch in front of the palace dates from this period. On it, you can see the Moldavian coat of arms and a Cyrillic inscription spelling out the words *the door of hope*. In 1860, the building became home to the newly established University of Iasi and to the first public art collection in the country. Today, it houses the Medicine and Pharmacy College.

**University on Copou Hill (Universitatea Alexandru Ioan Cuza)**
*Address: Blvd. Carol I nr. 11*

The main university building was built between 1893 and 1897 on the site of the Great Theatre which had burned down. The Hall of the University, known as *The Hall of the Lost Footsteps*, served as a parliamentary debating chamber between 1917 and 1918. In 1967, the painter Sabin Balasa created a series of strongly romanticized frescoes for the arcades.
Central University Library (*Biblioteca Centrala Universitara Mihai Eminescu*)
*Address: Str. Pacurari 4*
Located at the base of Copou Hill, this triangular building with Doric columns and cupola was built between 1930 and 1935 to serve as the headquarters of King Ferdinand's Cultural Foundation. The building was decorated with Carrara marble and Venetian mosaics. By 1945, the Foundation library had become one of the biggest in the country with more than 300,000 volumes. Today, the library is the largest in Moldavia, with a great number of manuscripts and old books from the

In 1943, after a storm almost brought it down, the tree was encircled with metal bands. Ten years later, its hollow center was filled with cement. In 1991, when the bands were cut off and the heavy filling removed, people noticed that the tree had live roots growing inside the hollow centre.

Copou has been a favorite place in Iasi for late afternoon strolls or morning walks since the second half of the 17th century. In 1834, Copou became the city's first public garden and in 1860, street lamps were installed for the first time.

Allegedly, it was here, under his favorite linden tree, that the Romanian National Poet, Mihai Eminescu (1850-1889), wrote some of his best work. The tree stands to this day and a bronze bust of the poet has been placed next to it.
Botanical Garden (Gradina Botanica Anastasie Fatu)
Address: Str. Dumbrava Rosie 7-9
Tel: (232) 201.373
Open: Daily 10am - 9pm

Dating from 1856 and covering some 250 acres, Iasi's Botanical Garden is the oldest and largest in Romania. An educational and scientific laboratory, the garden houses a precious and rich collection of trees and plants. It also offers numerous shady lanes to explore, rose and orchid gardens, a collection of tropical plants, cacti, carnivorous plants, natural springs and a lake.

CITY ESSENTIALS

Transportation

Iasi is easily accessible from Bucharest (Bucuresti) by plane (1 hour), train (approximately 6 hours) and car (approximately 6 ½ hours).

» By air Iasi International Airport (IAS)
Tel: (232) 271.570
Web: www.aeroport.ro

Airlines with service to Iasi:

Austrian Airlines - http://www.austrian.com/
Direct flights from/to: Vienna

Time table
Mon-Sun, without Saturday:
VIE: 10.40 - IAS: 13.25
IAS: 15.20 - VIE: 16.15
Mon-Sun, without Saturday has flights to Vienna and onwards 6 days per week.

**Carpat Air** - [www.carpatair.ro](http://www.carpatair.ro)

*Direct flights from/to: Timisoara(TSR)*

*Connecting flights (via Timisoara) from/to: Romania (Bucharest, Bacau, Cluj, Constanta, Craiova, Oradea, Sibiu, Suceava); France (Paris); Germany (Dusseldorf, Munich, Stuttgart); Greece (Athens); Hungary (Budapest); Italy (Bari, Bergamo/Milan, Bologna, Florence, Rome/Fiumicino, Venice, Verona, Torino); Republic of Moldova (Chisinau); Ukraine (Kiev, Lvov, Odessa)*

**Time table**

**Monday to Saturday:**
- IAS: 07.45 - TSR: 08.55
- TSR: 15.15 - IAS: 16.25

**Sunday,** 3 flights:
- OTP: 11.35 - IAS: 12.40
- OTP: 17.30 - IAS: 18.35
- OTP: 21.20 - IAS: 22.25

**Tarom** - [www.tarom.ro](http://www.tarom.ro)

*Direct flights from/to: Romania (Bucharest, Constanta); Austria (Vienna); Germany (Frankfurt); Italy (Bologna); Spain (Madrid); Switzerland (Geneva, Zurich)*

**Iasi to Bucharest:**

Monday to Friday, 4 flights each day:
- IAS: 06.00 - OTP: 07.05
- IAS: 10.15 - OTP: 11.20
- IAS: 13.00 - OTP: 14.05
- IAS: 18.55 - OTP: 20.00

**By train**

**Iasi Train Station (Gara de Nord Iasi)**

*Address: Str. Garii 1*

*Tel: (232) 410.636 or 215.600*

For the list of international trains with service to/from Romania please visit: [www.RomaniaTourism.com/Transportation.html#ByTrain](http://www.RomaniaTourism.com/Transportation.html#ByTrain)
To check the latest train schedules for domestic routes please visit the website of the Romanian Railways: www.infofer.ro
Note: For departures from/to Bucharest please select Bucuresti Nord.

**CFR's advance booking office** (Agentia CFR Iasi)
*Address: Str. Piața Unirii 10
*Tel: (232) 242.620
*Open: Mon. - Fri. 8:00am - 8:00pm; closed Sat. & Sun.*
You can get train schedule information and make reservations up to 24 hours in advance at this office. Tickets for same-day travel can only be purchased at the station.

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COST Action FA0904: Eco-sustainable food packaging based on polymer nanomaterials
Conference and WGs meeting, 28th-29th June 2010, Iasi, Romania

Tourist Offices
Iasi Tourist Information Centre
Address: Piata Unirii nr.12
Telephone: (232) 261.990
E-mail: turism.iasi@gmail.com
Web: www.turismiasi.ro/index.php?id=101

Hotels (recommended by the local organizers)

TRAIAN Grand Hotel ****
Piata Unirii Street, No. 1, Iasi
TRAIAN Grand Hotel Reservations:
Tel: +40 232 266 666
Fax: +40 232 212 187
E-mail: reservation@grandhoteltraian.ro
www.grandhoteltraian.ro

SELECT HOTEL ****
Piata 14 Decembrie 1989, No. 2, 700123 Iasi
Tel: +40 (232) 210 715
Fax: +40 (232) 216 444
E-mail: oficeselect@selectgrup.ro
www.selectgrup.ro

BEST WESTERN ASTORIA HOTEL ***
1 Lapusneanu Street, Iasi
Tel: +40 232 233 888s
Fax: +40 232 244777
E-mail: reservation@hotelastoria.ro
http://www.hotelastoria.ro/

UNIREA HOTEL ***
Piaţa Unirii Street No. 5 , 700056 Iasi

EUROPA HOTEL ***
St. Anastasie Panu Street, No. 26, Iasi
Tel.: +40-232-242000
Fax: +40-232-242001
E-mail: contact@hoteleuropa.ro
http://www.hoteleuropa.ro/index.html

RAMADA IASI CITY CENTER HOTEL ***
27 Grigore Ureche Street, 700023 Iasi
Ramada Iasi City Center Hotel Reservation:
Tel: (40 232) 256 070
Fax: (40 232) 215 037
E-mail: reservation@ramadaiasi.ro
www.ramadaiasi.ro

STUDIS HOSTEL ***
Otilia Cazimir Street, No. 10, Iasi
Tel: +40-332-107.152
Fax: +40-332-107.154
E-mail: rezervari@hotelstudis.ro
www.hotelstudis.ro

Public transportation

Iasi International Airport (IAS)
Tel: (232) 271.570
Web: www.aeroport.ro
Iasi Train Station (Gara de Nord Iasi)
Address: Str. Garii 1
Tel: (232) 410.636 or 215.600
Web: www.infofer.ro

CFR’s advance booking office (Agentia CFR Iasi)
Address: Str. Piata Uniri 10
Tel: (232) 242.620
Open: Mon. - Fri. 8:00am - 8:00pm;
closed Sat. & Sun.

Car rental
Cliven
Address: Str. Stefan cel Mare si Sfant 8-12,
Iasi
Tel: (232) 258.326
Email: office@cliven.ro
Web: www.reservation.ro

EuroCars Romania
Address: Strada Aeroport 1 (Iasi Airport)
Tel: 0727 37 37 99
Email: office@eurocars.ro
Web: www.eurocars.ro

Taxi companies
Delta Taxi - (232) 222.222
Euro Taxi - (232) 217.217
For You - (232) 222.444
Go Taxi - 944 or (232) 279.444
Taxi costs about 3 Euros.

Buses to / from “Petru Poni” Institute of Macromolecular Chemistry:
Traseul 28b: Piata ACB - Podu Ros - P. Eminescu - Rond Copou
Traseul 41: Rond Copou - Podu Ros - Rond CUG II
Traseul 43b: Rond Copou - Piata Independentei - Iulius Mall - T. Vladimirescu - CUG I

Trams to / from “Petru Poni” Institute of Macromolecular Chemistry:
Traseul 1: Rond Copou – T. Vladimirescu - Tatarasi – Rond Copou
Traseul 13: Rond Copou – Tg. Cucu - Tatarasi - T.Vladimirescu - Baza 3 - Bucsinescu

IASI - Useful Contacts

<table>
<thead>
<tr>
<th>Iasi Area Code (Prefix Iasi)</th>
<th>0232</th>
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<tbody>
<tr>
<td>Ambulance (Ambulanta)</td>
<td>961</td>
</tr>
<tr>
<td>Police (Politia)</td>
<td>955</td>
</tr>
<tr>
<td>Fire Department (Pompierii)</td>
<td>981</td>
</tr>
<tr>
<td>Emergency Clinic Hospital (Spitalul Clinic de Urgente Iasi)</td>
<td>(232) 216.584</td>
</tr>
<tr>
<td>City Hall (Primaria)</td>
<td>(232) 267.582</td>
</tr>
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</table>
ABSTRACT BOOK

Conference and WG meetings
COST Action FA0904
“Eco-sustainable food packaging based on polymer nanomaterials”
28th - 29th June 2010

SESSION I
Monday, June 28th, 2010
Towards new safe nanomaterials for food packaging

VÄHÄ-NISSI Mika

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The main functions of a package are to contain the product, to preserve and to protect it throughout the anticipated shelf life, to sell the product, to inform and to assist the consumer when consuming the product. Typical requirements set on packaging concepts today include cost reduction, increased shelf appeal, improved security, safety and performance. Sustainability and small carbon/water footprints are today essential when developing materials and solutions as indicated by several brand owners and large retailer chains. As part of this development environmental concerns have become important and considerable efforts have been made to replace oil-based materials and aluminium foil with environmentally friendly biodegradable or recyclable materials from natural sources. In addition, the classical three R’s (reduce, re-use, recycle) connected to packaging waste are complemented by recover, renew and rethink emphasizing the design function as a tool in reducing the amount of waste. This COST action and related research work help to understand and characterize the fundamental interactions thus providing basis for developing sustainable and light-weight packaging materials and new package features.

Nanotechnology, i.e. manipulation of materials measuring 100 nm or less in at least one dimension, is generally expected to be a driver for global economic growth and development. This multi-disciplinary field has made foray into packaging industry and developments are taking place rapidly in this area. The benefits of using nanotechnology include longer shelf life, improved mechanical, thermal and barrier properties, thinner films, conductivity, optical and surface properties, functionality enabled by printable electronics, brand protection and traceability, antimicrobial and special sensory features. The technical solutions for these may vary. However, nanotechnology faces technical challenges and resistance from the food supply chain or the consumer due to the apparent threats or uncertainties.

New polymer nanomaterials provide enhanced performance by further adding safety, cost efficiency and environmental advantages. These materials are divided into improved, active and intelligent describing the main effect of nanotechnology ranging from passive to interactive features. Development of new nanomaterials for food packaging (PNFP) requires taking into account various parameters and evaluation tools. The role of this Working Group is to consider new types of PNFP – possibly also from other applications – and new scientific and technological breakthroughs and complementary knowledge leading to new features gained through nanotechnology. Following topics are covered in WG1:
• Selection, synthesis and/or production of matrix, nanoparticles and –devices,
• Surface functionalization and chemical treatments of nanoparticles,
• Link between nanostructures and macroscopic properties,
• Characterization and measurement tools.

The classical means for improving barrier, mechanical and thermal properties of both synthetic polymers and biopolymers from renewable resources include montmorillonite layered silicates. These have been utilized for both melt processed polymers and aqueous polymer dispersions. However, special care is needed when tailoring the montmorillonite surface properties with for specific polymers and when dispersing these particles into the polymer matrix. Polymerization in the presence of nanoparticles opens also interesting options. However, developing new modifier for clay surface constitutes as well a new product with related registration costs. Montmorillonites require likewise often a special dispersing process when aiming at aqueous coatings. Although nanoclays enable thinner layers of e.g. polyamide or polyester with improved properties, the improvement is not necessary good enough to upgrade e.g. polyolefins or to turn biopolymers into efficient moisture barriers. In such cases it might be useful to look into nanolayered surface treatments. Inorganic or hybrid structured nanolayers applied by e.g. layer-by-layer assembly or atomic layer deposition (ALD) techniques allow precise control over the film structure and even more dramatic improvements in the functional properties – even allowing the replacement of aluminum foil in the near future. Other techniques, such as liquid flame spray nanocoating for flexible materials, are being developed to control the surface properties of packaging materials. In addition, new types of organic and inorganic nanoparticles are being introduced to the market place. Nanofibers (including cellulose) provide an interesting platform for packaging material development. In addition to functional purposes, nanotechnology can be used for creating decorative features. Nanotechnology allows also material and energy savings during material production or use of new types of compounds in classical processes (such as cyclodextrins in emulsion polymerization).

Permselective and active features created by nanotechnology affect the surface properties or the interior of the package. The classical examples of active features used for food packaging are antimicrobials and oxygen scavengers. Silver nanoparticles are well known for providing antimicrobial properties, and nano-sized iron particles provide oxygen absorption. However, there are significant concerns that nanoparticles – if leaking to soil or water – may have detrimental effects on natural microbes. Therefore, there is significant interest to look at the hybrid solutions and biobased alternatives. Bioactive materials are also being developed by adding enzymes to coatings or inks, by attaching enzymes to the material surfaces by e.g. plasma or by any other cost efficient process. Stimuli responsive materials provide numerous ideas for adjusting the packaging material properties.

Sensors and (printed) indicators are being added to packaging materials to monitor and to provide information about temperature and integrated time-temperature history, moisture content, storage time, mold and other biological hazards, head space gas composition and pH, while passive sensors provide identification for tracking/tracing/recycling purposes. Biotechnology creates new enzymatic tools for
sensor applications. Printed displays replacing conventional labels, sensors and other printed electronics on packages can in the future be powered by power cells included in the packaging material.

In order to be able adequately understand nanoparticles and nanofibers, nanostructures and eventually nanocomposites and their properties new characterization tools are needed. This enables linking the key parameters in nanoscale and the processing parameters to the macroscopic performance of the materials. Typical modeled properties include heat and mass transfer.
Active NanoBioComposites of Interest in Food Packaging Applications

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The present talk outlines recent results carried out within our research group in which active natural nanoadditives provide different simultaneous functionalities such as gas and vapour barrier, antimicrobial and oxygen scavenging properties to bioplastics. Bioplastics are generally perceived as materials with insufficient properties to replace petroleum-based plastics in many packaging applications and hence nanostructuration and/or reinforcement of these with natural fillers is a valid route to generally enhance their performance. The current talk will present strategies that develop active nanoclays to reinforce bioplastics with interest in food packaging applications.
The preparation and exploitation of safe nanoparticles in polymer films for food packaging

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The addition of small quantities of nanoparticles to conventional and sustainable thermoplastics leads to property enhancements with considerable potential in areas where control of gas permeability is a major requirement. Foodstuffs need appropriate packaging to ensure maintenance of the quality and freshness of the food during both storage and transportation. Effective packaging can extend shelf life by controlling the movement of water vapour and other gases including volatile components such as flavours. Most engineered nano-particles are highly stable and these exist as nano-particles prior to compounding with the polymer resin, they remain as nano-particles during the active use of the packaging as well as in the subsequent waste and recycling streams. The latter presents real challenges to the recycling process, unless highly selective sorting is in place. There is public concern as to the potential for the transfer of the nano-particles to the food or hands of the user, although the evidence available to date suggests that these effects are mostly minimal.

In this presentation we explore the potential for constructing nano-particles within the polymer films during processing from organic compounds selected to present minimal or no potential health hazards. These compounds could be post-use-processed together with the polymer matrix whether that processing is biodegradation, recycling or incineration. Engineered nano-particles can be rod like, plate like or spherical in nature. Using the results from initial studies we show how nano-particles based on organic compounds can clarify the polymer films and modify the structure and morphology of the polymer matrix leading to property changes. These nano-particles are rod-like in shape. We consider the key requirements for other possible organic compounds which could be exploited in this manner, for example the generation of plate-like and spherical particles and we review the potential for success using this approach.

WG-Number: WG 1WG 1
The role of bacterial biofilm and oxidizing enzymes in biodegradation of plastics

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Polyethylene is considered as one of the most durable synthetic polymers. Consequently, non-biodegradable polyethylene accumulates in the environment posing an escalating ecological threat to man and wildlife. Moreover, recent reports indicate that nano-scale polyethylene penetrate into the food chain. We previously isolated a strain of the bacterium Rhodococcus ruber (designated C208; EC 1.10.3.2.) that was capable of utilizing and degrading polyethylene. Here, we report on the role of the bacterial copper-binding enzyme, laccase in the oxidation and degradation of polyethylene by this strain. Copper markedly affected the induction and activity of laccase, resulting in polyethylene undisclosed-recipients: degradation. RT-PCR, facilitating quantification of mRNA induction, showed a 13-fold increase in laccase mRNA levels as compared with the untreated control. Addition of copper to C208 cultures containing polyethylene enhanced the biodegradation of polyethylene by 75%, as compared with the non-amended control. Furthermore, when an extracellular isoform of laccase collected from the media of copper-induced cells was incubated with polyethylene, reductions of 20% and 15% were obtained in the Average Molecular Weight and Average Molecular Number respectively were obtained Fourier transformed infra red spectroscopy analysis or in the biodegradation of polyethylene. In liquid cultures, containing polyethylene films, C208 formed a biofilm that showed high affinity to the plastic surface. In order to study the role of the biofilm in the biodegradation of polyethylene we have isolated mutants that were impaired in biofilm production. Incubation of a cell free extract, containing the extracellular laccase, exhibited an increase in the carbonyl peak, indicating that enzymatic oxidation by laccase plays a major role in the biodegradation of polyethylene. This study ‘may pave the way’ for the development of a method for minimizing plastic waste.
Nano- and microsized starch derivatives and their applications

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The development of new materials tailored at molecular and nanometric levels, based on polysaccharides, requires mastering the chemistry of biopolymers together with additional knowledge in surface and interface interactions, nanoscience, physics, mechanics and processing, synthetic polymers and inorganics. Starch is one of the most important renewable polymers for humanity, both in terms of food science and as renewable resource for the development of new biodegradable functional materials. Furthermore, it could be easily modified and new innovative materials with tailored properties obtained.

Our research is aimed to create new techniques and develop new methods of starch modification, which would enable the preparation of highly charged polysaccharide derivatives possessing an appropriate structure as well as their nano-derivatives applicable in various (including food packaging) technologies. The exploration is carried out in several domains: creation of the methods to obtain microgranular high charge density cationic or anionic starches; evaluation of structure and properties of new polysaccharide derivatives; production of nanoderivatives from modified ionogenic polysaccharides and prototypes for their fabrication; preparation of polyampholytes from polysaccharides by chemical and biochemical methods; assessment of functional qualities of the new products and their applications as adsorbents, wastewater cleaning agents, adhesives, antibacterial agents etc.

The preparation of charged nanoparticles has been achieved through the complex formation of the macromolecules of water soluble starch derivatives with polyfunctional low molecular weight compounds of opposite charge. Thus prepared modified starch nanoparticles possessing desirable properties could be used as functional additives in food packaging films as well as covers. In order to impart to starch nano- and microparticles the antimicrobial activity, the iodine modification of obtained products has been performed. Additionally, the formation of the polysaccharide-iodide-iodine complexes was investigated. The modified nanoparticles and microgranules were immobilized into different polymer matrixes (polyvinyl alcohol, cellulose diacetate, hydroxyethyl cellulose) and the network of nanofibers. The antibacterial properties of the obtained materials were assessed.
Preliminary investigation has confirmed an excellent antibacterial activity of cationic starch-iodide-iodine complexes against the tested microorganisms. The investigated systems could be considered as potential materials for fabrication of biodegradable films and covers with antimicrobial properties.
Tailoring of polymeric materials at the nanoscale for sustainable packaging

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While the major requirements for food packaging remain passive containment and protection, there is increasing emphasis on the development of technologies for sustainable packaging, i.e. packaging that contributes to the long term viability and quality of life for humans and the longevity of natural ecosystems. Added functionality for product monitoring, active protection and safety is clearly one important aspect of sustainable packaging, but the choice of materials is also dictated by the need to reduce its overall environmental impact, by e.g. use of sustainable resources, weight saving, recycling and improved biodegradability, whilst respecting cost imperatives. This presentation will review current activities in this field in the LTC-EPFL, focusing on the use of nanoscale modification of polymeric packing for the reduction of oxygen and water permeability and the replacement of conventional plastics by more “eco-friendly” nanocomposite materials. Conventional polymeric materials represent attractive alternatives to other packaging materials such as glass, steel and aluminium, thanks to their low densities and processing temperatures, but they have the disadvantages of limited gas barrier performance and reliance on non-renewable resources. Two approaches to improving barrier performance will be discussed: (i) internal dispersions of high aspect ratio impermeable inorganic nanoplatelets, with the aim of maximizing the tortuosity of diffusion paths at low loadings and (ii) the use of continuous inorganic nanosized barrier coatings, which may provide dramatic reductions in permeability, but whose performance remains sensitive to defects resulting from both processing and damage in service. Such technologies are in principle applicable to any type of conventional polymer packaging material, but there is growing interest in combining them with biodegradable matrix materials derived from renewable resources. A key idea here is to meet performance criteria using polymers of biological origin, such as polylactides and starch-based thermoplastics with reinforcing fillers that are themselves based on sustainable resources (“green” nanocomposites). The discussion will centre on how such materials may be combined with conventional processing techniques to produce cost-effective solutions for e.g. the replacement of styrenics in foam packaging.

References

Influence of organically modified montmorillonite on processing and mechanical properties of polycarbonate

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Nanocomposites of polycarbonate (PC) and natural montmorillonite (Nanocor Nanomer PGW) or chemically modified clay (Nanocor Nanomer I.30P or Nanocor Nanomer I.44P) were prepared by melt blending in HAAKE roller-type mixer. Both used organoclays belong to a group of quaternary ammonium modified montmorillonites (MMTs). In all PC/Nanomer composites the concentration of clay was 5 wt%. Thermogravimetric analyze has evidenced that the thermal decomposition of organically modified montmorillonite starts in the range of 220-230ºC, while the thermal stability of PC/clay nanocomposites is much higher and begins at 320ºC. The linear dynamic viscoelasticity measurements have shown that the PC/clay nanocomposites containing organically modified montmorillonite reveal strong thermal degradation, which may result from the quaternary ammonium salts decomposition during the mixing processing and further initiates a thermal degradation of the matrix polymer (Fig. 1). Influence of a montmorillonite modifier on other polymers has been also tested and evidenced higher sensitivity to degradation of polycarbonate in comparison to other plastics. Influence of a degradation to the mechanical properties has been tested and related to possible structural changes. Comparative studies has been performed also for another nanofiller (precipitated calcium carbonate), which allowed a conclusion on a degrading influence of the organic MMT modifier to polycarbonate.

![Fig. 1. Melt viscosity of polycarbonate and PC filled with organically modified montmorillonite](image)
Within the available arsenal of preservation techniques, the food industry is increasingly investigating the replacement of traditional food preservation techniques (intense heat treatments, salting, acidification, drying and chemical preservation) by new technologies. The most investigated of the latter are non-thermal inactivation processes where active packaging holds a considerable place. Because the microbial contamination of meat products occurs primarily at the surface, due to post-processing handling, the use of packaging films containing antimicrobial agents could be more efficient, by slow migration to the food surface, thus helping to maintain high concentrations where they are needed.

The interest in chitosan is increasing due to its renewable character and its special properties such as its fungicide and bactericide action. However, the use of chitosan is limited because it can be only processed from aqueous solution in the presence of acids such as acetic and formic acids. Combination of the good mechanical properties of LDPE with the biodegradability and antimicrobial characteristics of chitosan based nanoparticles could be an alternative method for obtaining performant packing materials.

Present study deals with the preparation of blends containing chitosan/ montmorillonite MMT nanocomposites and low density polyethylene (LDPE) by a protocol involving two steps. In the first stage a chitosan/ (MMT) masterbatch was prepared by the solution method then this was blended with LDPE by melt processing. The obtained systems showed higher thermal stability and improved mechanical properties.
Bio-hybrid nanocomposite packaging materials from polysaccharides and nanoclay

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In recent years a lot of effort has been aimed at developing new bio-hybrid nanocomposite barrier packaging materials for foods. Nanocomposite films and coatings with improved properties were produced from nanoclay and polysaccharides such as ultrasonic dispersed chitosan and high pressure fluidized pectin. Bio-hybrid coatings from chitosan and nanoclay were applied onto argon-plasma-activated LDPE coated paper. The intercalation of chitosan in the silicate layers was confirmed by the decrease of diffraction angles while the chitosan/nanoclay ratio increased. Nanocomposite films and multilayer coatings had improved barrier properties against oxygen, water vapour, grease and UV-light transmission. Oxygen transmission was significantly reduced under all humidity conditions. In dry conditions, over 99% reduction and at 80% relative humidity almost 75% reduction in oxygen transmission rates was obtained. Hydrophilic chitosan was lacking the capability of preventing water vapour transmission, thus total barrier effect of nanoclay containing films was not more than 15% as compared to pure chitosan. Nanoclay containing coatings did not have any antimicrobial activity against *Staphylococcus aureus* or *Escherichia coli*. All coating raw materials were “generally recognized as safe” (GRAS) and the calculated total migration was in all cases \(\leq 6\) mg/dm\(^2\) thus the coatings met the requirements set by the packaging legislation. Processing of the developed bio-hybrid nanocomposite coated materials was safe as the amounts of released particles under rubbing conditions were comparable to the particle concentrations in a normal office environment. Nanoclay-pectin hybrid film formation and high shear induced orientation of nanoclay platelets were investigated by means of model surfaces which were prepared using high shear spincoating. After fluidisation, the nanoclay formed uniform and laterally oriented stacks consisting of approximately 15 individual nanoclay layers. Pectin films with final nanoclay concentrations of 0, 10, 20 and 30 wt% were prepared by casting. Nanocomposite films made of pectin and nanoclay showed improved barrier properties against oxygen, and water vapour. Films were also totally impermeable to grease. The developed bio-hybrid nanocomposite packaging materials can be potentially exploited as a safe and environmentally sound alternative for synthetic barrier packaging materials.
References

SESSION II

Tuesday, June 29th, 2010
Plenary lecture: Leader WG 3

*Current state of knowledge in regard to interaction of PNFP with packaged food products*

*CHAUDHRY QASIM*
Polymers have been used in food and drink packaging for many years, and now polymer nanomaterials for packaging are extensively researched and some are already in production. Some of the old polymers caused environmental, health safety (EHS) problems and a proportion of those were serious and some are still controversial. As a result of such problems in the field of polymer production and distribution, and many other EHS-adverse technological innovations in the past few decades, the European Union has adopted the Precautionary Principle.

I maintain that this Principle must now be applied to the new generation of nano-based polymers, particularly for food-contact materials, since there are many uncertainties in the characterisation and hazard assessment of these new polymers and toxicologists are already having some success in identifying specific risks.

The Precautionary Principle has many formulations, depending on what one wishes to emphasize. The main one is derived from that enshrined at the 1992 Rio Conference on the Environment and Development, during which the Rio Declaration was adopted, whose principle 15 states that:

“...in order to protect the environment, the precautionary approach shall be widely applied by States according to their capability. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation” (1).

The Principle, and its importance as a conceptual framework for regulatory and legal purposes, was laid out in 2000 in a special EU communication (2). I shall summarise the main points of this framework showing how it is relevant to the development of novel packaging and food-contact materials.

I shall give some past and current examples where polymer (plastics) production and distribution has caused seriously adverse EHS impacts, and suggest that we must learn from these experiences. The past can provide precautionary lessons for the future of polymer nanomaterials in packaging (3). I will refer to cases such as the now widespread concerns about PVC and phthalates, and bisphenol-A and brominated flame retardants. It is significant for risk policy and communication that, for example, bisphenol-A was suspected of being hazardous since the 1930s’, yet appropriate policies were not adopted and actions were not taken.

Although not all my examples are food-contact polymer materials they do serve to make the general point that, although we certainly need the environmental and other benefits that novel materials can bring, we need the cooperation of manufacturers in observing the Precautionary Principle and its preemptive safety requirements, within the context of a ‘level playing field’ of regulation.
It is to be noted that many past problems with polymer materials have issued not so much from the characteristics of the polymer itself but from additives, corollary substances in the production processes and breakdown substances. Will there be the same ‘secondary’ impacts from new polymer nanomaterials? We have to look at the whole life-cycle of such novel materials, from the manufacturing process, through use and misuse, to proper and improper disposal. We must learn to understand the Precautionary Principle, new approaches to hazard and risk assessment, policy and regulation.

Nano-based polymers may provide safe alternatives, with enormous additional benefits - but only if we learn to think ahead and implement fair and precautionary policies.

References

Carbon based nanomaterials suitable for detection of bacteria and biofilms on the surface of Plastic films

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Plastic films are highly susceptible to contamination caused by biofilms produced on their surfaces when they are used in various applications such as food packaging. The aim of this work was to examine the suitability of carbon nanomaterials such as carbon nanotubes and multilayer graphene nanoplatelets for the detection of bacteria and biofilm development on the surface of PET based plastic films. The results showed that this method could clearly identify the presence of bacteria between 10^2 - 10^8 cfu / ml.
WG 3 and WG 4

Biodegradable nanocomposites for packaging and protection of consumer goods

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Nanostructured materials are increasingly used in various branches of national economy, including packaging. Extensive use of nanoparticulate matter as bulk materials and modifiers of metal, ceramic and polymer matrices are determined by it small dimensions, high surface area, desirable aspect ratio and shape. Thus, use of placoid nanoparticulates as modifiers of polymer matrices allow development of the materials with improved barrier properties [1]; use of biodegradable matrices [2] gives an additional added value for the development of effective environmentally friendly packaging materials; introduction of liquid crystalline modifier [3] can facilitate processing and enhance certain exploitation characteristics (int. al. mechanical as well as vapour and gas barrier properties) of traditional polymers, their composites and nanocomposites; use of specific anisometric fibrous or tubular nanofiller (such as CNT for an example) [4] can be important for development of certain specific “smart materials” for numerous barrier, protective and sensor applications; development of polymers with magnetic nanofillers [5] allows assign specific magnetic characteristics to typical diamagnetic materials. It is important to mention that these property enhancements are achieved already at much lower modifier contents (even below 0,1 wt/ %) than in the case of traditional microcomposites.

In the current report results of biodegradable polymer nanocomposites, modified with layered silicates have been investigated. Native potato starch has been used as starting material for development of environmentally friendly nanocomposites. Biodegradable polymer matrix has been manufactured by means of its modification with glycerol as plasticizer and thermoplastic shear action. Starch based material has been additionally modified with native unmodified and organically modified layered silicates (Montmorillonite clay). Structural, mechanical and barrier properties of the nanocomposites have been investigated. In addition specific mathematical models for predicting of elastic and moisture vapour sorption properties of the nanocomposites have been developed. The results of the investigation testify about 1) the development of exfoliated and intercalated structure of the nanocomposites, as well as about 2) the considerable reinforcing effect of minor amounts of the layered silicate nanofiller on the mechanical and barrier properties of the investigated nanocomposites even at elevated moisture contents. Validation of the developed theoretical models with experimental results has been also carried out.

References
Zinc Oxide in Polymeric Matrices: Synthesis of the Sub-Micronic Powders, Processing and Anti-microbial Activity of the Composites

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The antimicrobial activity against E. coli, St. aureus and A. niger of zinc oxide when blended with polymers has been measured by an applied dynamic method, and compared with those of pure ZnO nanoparticles.

The zinc oxide nanoparticles were obtained in a pilot scale platform by spray pyrolysis (SP). This process takes place at relatively moderated temperatures (600-700°C): micrometric droplets of a precursor (zinc nitrate) solution are dried and decomposed to the required compound. The chemical reactions occurring are the precipitation from solutions, simultaneously with the evaporation of the volatile species: water and nitrate vapours. In the “biphasic spray-pyrolysis”, a second nitrate has been added to the initial solution, so that at the end of the reaction each micronic particle consists of un-miscible sub-particles: ZnO and a second compound, which is afterwards preferentially dissolved and removed [1]. SEM and XRD of the pure ZnO nanoparticles are exemplified in the figure.

Two polymers: poly(amide) 6 (PA6) and low density poly(ethylene) (LDPE) have been used as matrices. Samples elaboration was made by blending polymer matrix (LDPE or PA6) with ZnO in a mini extruder: their antibacterial activity has been tested as described in [2]. ZnO nanoparticles content as low as 1% w/w in the polymers showed great antibacterial activity but no antifungal activity. The results of bacterial slaying capability of these nanocomposites was also found to be better when zinc oxide was dispersed in PA6, where the efficiency is similar to pure ZnO particles.

References


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WG 3 and WG 4
The present work consists on the development and characterization of novel hybrid materials obtained through electrospinning based on an EVOH matrix with bacterial cellulose nanowhiskers. These materials are intended to serve as a vehicle for incorporation of dispersed cellulose nanowhiskers into biodegradable matrices for food packaging applications.

Bacterial cellulose was selected as the reinforcing agent due to its structure and unique properties, such as high crystallinity, high degree of purity, low density and biocompatibility. Furthermore, while plant cellulose is associated with other kinds of natural biopolymers like lignin and hemicellulose, bacterial cellulose is almost pure. These outstanding properties have made bacterial cellulose to gain interest to reinforce nanocomposite biopolymeric materials (1-4).

It will be shown how the bacterial cellulose nanowhiskers (BCNW) were obtained by means of an acid treatment, as well as the morphological characterization through SEM and optical microscopy with polarized light. X-ray diffraction (XRD) confirmed the increase in crystallinity of the cellulosic material after the acid treatment and the XRD patterns showed a crystalline structure which was a combination of cellulose I and cellulose II allomorphs. Nevertheless, the thermal stability of the material was compromised due to the presence of sulphate groups on the surface of the nanowhiskers, as observed through TGA.

The obtained cellulose nanowhiskers were incorporated into an EVOH matrix by electrospinning, generating hybrid reinforced fibre-like materials. Cellulose nanowhiskers were added both freeze-dried and hydrated (which will be referred as freeze-dried and centrifuged BCNW, respectively). Sonication was also considered to further disperse the nanowhiskers. Morphology of the electrospun fibres was studied by SEM and FT-IR was used to estimate the degree of incorporation of the reinforcement. The latter technique showed that centrifuged BCNW without sonication was the most effective method of incorporation.

By means of the optimized method, electrospun EVOH fibres containing different amounts of centrifuged BCNW were generated and characterized using several techniques. FT-IR showed that incorporation of the BCNW was effective for concentrations up to 20 wt.-%.

Electrospinning has proved to be an interesting route to obtain hybrid fibres assuring a proper dispersion of the nanoreinforcing agent, which can be of interest in the development of novel reinforced biodegradable packaging materials.

References

NanoPack – a Danish research project on bio-nanocomposites for meat packaging

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The use of biodegradable plastics for food packaging has been relatively limited because of poor barrier properties, microbiological instability and high price. For example, although polylactide (PLA) has significant potential and has already found application for packaging of fruits, vegetables, yoghurt and beverages (e.g., water), further use has so far been held back by its brittle nature and low glass transition temperature as well as its inferior water vapour and gas barrier properties. As a result, PLA is not suitable at present for modified atmosphere packaging (MAP), as might be used for some meat products.

The production and use of polymer-clay nanocomposites has potential as a means of obtaining a wide range of property improvements and this topic has been reviewed both in general terms as well as with respect to PLA in particular. Implementation of this technology might therefore provide a route to PLA films for a wider variety of food packaging uses.

Supported by funding from the Danish Strategic Research Council, a team of researchers from five different organizations has been investigating methods for enhancing the properties of PLA films so that thermoformed trays produced from such films might be suitable for the packaging of meat products. The partners in the project are Rise DTU, DTU Food, the Faculty of Life Sciences at the University of Copenhagen (KU), Færch Plast A/S and the Danish Meat Research Institute, now part of the Danish Technological Institute. The project, entitled NanoPack, has as its overall goal the development of a technological basis to use PLA nanocomposites in a way that meets customer demands for functionality, sustainability and safety, with the various partners providing expertise in polymer chemistry, clay science, toxicology, food safety and packaging technology. Specific project objectives have included improved barrier properties through incorporation of organoclayes, transfer of knowledge from the laboratory to semi-scale film and tray production, development of new analytical methods for migration and toxicological studies, the establishment of a packaging shelf life trial and the dissemination of information from the project to key stakeholders.
The NanoPack project has been carried out in three work packages: 1) raw material acquisition and film production, 2) characterisation of performance in relation to food packaging, and 3) risk characterisation. The raw materials used in the project have included commercial PLA (NatureWorks® 2002D or 2003D grades), Cloisite® organoclays (Southern Clay Products) and organomodified anionic clays synthesised in the laboratory at KU. \textit{In-situ} polymerization has also been investigated as a way to obtain PLA nanocomposite masterbatches and to thereby avoid the direct mixing of organoclay fillers with the polymer in a manufacturing environment. The physical properties of films produced either by solution casting or melt mixing have been characterised with particular attention paid to polymer molecular weight, barrier properties, thermal characteristics and clay dispersion.

The presentation will describe key findings to date and their significance for the NanoPack project as a whole, including the production and use of PLA nanocomposite masterbatches, PLA film permeability reduction, a new instrumental method for characterising nanoparticles\textsuperscript{6} and the findings from toxicity studies.\textsuperscript{7} The plans for the final year of the project and the expected results will also be summarised.

\textbf{References}

COST Action FA0904: Eco-sustainable food packaging based on polymer nanomaterials

Conference and WGs meeting, 28th-29th June 2010, Iasi, Romania

WG 1,2

NAPOLYNET EUROPEAN OPEN LABORATORY
Experimental Mechanics of Micro & Nanomaterials

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European Open Laboratory on Characterization of Polymer Nanomaterials, EOL-Napolynet (http://www.napolynet.eu), was set up within the project FP7-NMP-2007-CSA-218331 NaPolyNet.

MISSION: The mission of EOL is to: (i) provide services and network at European level of Laboratories and Top Experts on characterization of polymer nanomaterials in the field of packaging, textiles and membranes; (ii) make available the latest experimental and theoretical strategies in the field of polymer nanomaterials characterization, standardization and safety; (iii) facilitate transnational access to important and unique measuring techniques; (iv) contribute to the training and mobility of young scientists, SME engineers and users of those equipment; (v) bridge the gap between scientific and engineering approaches for polymer nanocomposite materials characterization and modelling.

FIELDS OF COMPETENCES: The EOL-Napolynet works on seven fields of competence in polymer nanomaterials characterization: 1. Processing; (2) Structure and morphology; (3) Thermal analysis and fast scanning calorimetry; (4) Properties (mechanical, thermal, electrical and permeability) (5) Molecular dynamics; (6) Membrane processes; (7) Standardization and safety.

Open Laboratory on Experimental Mechanics of Micro & Nanomaterials (OLEM) is established at the Bulgarian Academy of Sciences (http://www.clphchm.bas.bg/en/laboratories.html). OLEM carry testing of materials for a research and industrial needs, and it operates on national and international level. OLEM is a member of the EOL-Napolynet.

OLEM is equipped with advanced techniques for rheology and mechanical testing of micro- and nanostructured materials, liquids and solids, as follows:

1) AR-G2 RHEOMETER & DMTA (TA Instruments)
2) NANOINDENTER with AFM, 3-D and 2-D PROFILOMETERS (CETR,USA)
3) MECHANICAL AND TRIBOLOGY TESTER (CETR,USA) includes: Tribometer (tribology by linear and rotary drive, friction and wear, scratch); and Micro & MacroMechanics tester (tensile, bending, compression, torsion, tension-torsion, fatigue, microhardness, creep & relaxation).

Field of competence: polymer nanocomposites for packaging and electronics application; optimizing of processing; design and characterization of nano-, micro- and macromechanical properties of polymer nanocomposites.

Rheology of nanocomposites: We propose rheological methodology for establishing optimum conditions for dispersing of nanofiller in polymer. Rheological methods allow to select the best processing conditions and the best dispersions at an early stage of nanocomposite preparation. The rheological methods are proposed as a very useful practical tool for a design of novel nanocomposite materials, with a desired structure and enhanced performance.

Rheology-structure-property relationship is defined as a “window” between the rheological flocculation and percolation thresholds, where the maximum enhancement of properties is obtained. Mechanical properties improvement of polymer nanocomposites is strongly dependent of the flocculated and network structure formed by the nanofiller in polymer.

Current Projects: OLEM is a partner of 3 European projects, as follows: COST Action FA0904, FP7-CSA-218331 NaPolyNet (2008-2011); FP7-INCO-2010-266529 Belarus in ERA.
Widening. Our work is supported also by the national research infrastructure project NSF-BG (DO-02-53/08) and the bilateral cooperation project BAS-Bulgaria and CNR-Italy (2010-2013).

References
A novel antibacterial material from starch was synthesized facilely by a two-step approach. Firstly, cross-linked N-(2-hydroxy)propyl-3-trimethylammonium starch chloride (CCS) was synthesized by the reaction of glycidyltrimethylammonium chloride and epichlorohydrine mixture and starch. Biodegradable CCS with preserved microgranules and degree of substitution (DS) of 0.2-0.6 and the reaction efficiency from 82% to 93% was obtained. Subsequently CCS underwent complexation with iodine in aqueous iodine-iodide solution:

\[
\text{Starch} \xrightarrow{\text{Reaction}} \text{CCS} \xrightarrow{\text{I}_2} \text{CCSI}_2.
\]

Investigation of iodine binding by different cationic starches at equilibrium showed that modified starches with high number of quaternary ammonium groups were able to bind about 100 wt % of iodine from KI-I₂ solution and formed cationic starch-iodine complexes (CCSI₂). Whereas CCS with low DS simultaneously formed blue colour cross-linked starch-iodine (CS-I₂) and brown colour quaternary ammonium groups-iodine complexes. The stability in water, thermal properties (TG, DSC measurements) as well as antimicrobial activity of modified starch-iodine complexes were evaluated. CCSI₂ was the most stable complex and released iodine into environment only by presence of iodine acceptors. The antibacterial activity of different cationic starch derivatives against a various strains gram-negative and gram-positive bacteria was investigated by measuring the inhibition zone diameter (agar diffusion plate test). It was found, that cationic starches without iodine were bacteriostatic rather than bactericidal. However, CCSI₂ were more effective biocides than CS-I₂ and showed an excellent prolonged antibacterial activity. The high activity of cationic starch–iodine complexes has been essentially attributed to the iodine ingredient action derived by split of complexes and penetration into the bacterial cells.
Potential use of the lignin-polyolefin films in food packaging applications

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The most relevant applications of the plastics are considered in the packaging and agricultural industry. Packaging materials have to prevent product deterioration due to the physicochemical or biological factors and it is necessary to biodegrade in a reasonable time period without causing environmental waste problems. From this reason, biodegradable polymers have some beneficial properties as packaging materials in improving food quality through minimizing microbial growth in the product [1]. Biopolymers permit incorporation a wide variety of additives, such as antioxidants, antifungal, antimicrobials and other nutrients [2]. Incorporation of the natural polymers (protein, polysaccharides) in the synthetic polymer matrix leads to improve their mechanical and water vapor barrier properties [3].

Also, it has been found that lignin, a cheap by-product of wood pulping, can be blended with synthetic polymer giving materials with the improved physico-mechanical and dielectrical properties and increased thermal stability. Due to its the phenolpropanoidic structure similar to that of hindered phenols, lignin can acts as stabilizer [4], antioxidant [5] or initiator of polymer biodegradation [6].

The present study was designed to evaluate the possibility of new applications of lignins in the packaging field. In this aim the lignosulfonate or epoxy-modified lignosulfonate /polypropylene composites were compounded by melt blending in a HAAKE RHEOCORD 9000 mixer. To obtain a better dispersion and adhesion between lignin particles and polyolefin matrix a compatibilizing agent (ethylene-proylene rubber grafted with maleic anhydride, EP-MA) has been used. Processing parameters from torque-time curves, some mechanical properties such as tensile parameters like Young Modulus, stress and elongation at break and rheological behaviour were evaluated.

References

WG1 – WG4

Sustainability and life cycle assessment for food packaging applying polymer nanomaterials

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Sustainability assessment is an approach that combines the evaluation of environmental, economic and social aspects related to a product. Another important principle related to sustainability is life cycle thinking. Life cycle thinking means that the producer should consider the potential impacts of the product over all stages of the product life cycle. By conducting a systematical overview, risks of shifting the potential burdens between different life cycle stages or individual processes can be recognized and possibly avoided (ISO 14040). Life cycle thinking and sustainability assessment should be integrated as part of new material and product development already at the early stage of the development.

The poster presents a sustainability assessment approach that can be applied when new food packaging materials are developed. Important environmental aspects related to food packaging include e.g. emissions created during raw material acquisition and manufacturing, use of resources, recyclability and handling of the material as waste. Life cycle assessment (LCA) is a tool that can be used when evaluating the potential environmental impacts of a product. In LCA material and energy flows, emissions to air, water and soil and use of resources are defined. Based on detailed analysis of all inputs and outputs of the product system, potential for reducing the environmental impacts can be found. From environmental point of view, critical aspect is also the ability of the packaging material to protect the packaged products (e.g. barrier properties). For food packaging, other important aspects related to sustainability include product safety, profitability, expectations from the stakeholders and regulatory demands.

In addition to safety and risk assessment related to the packaging material, also the social acceptability of the product should be considered. Social acceptability includes aspects such as sustainable raw material sourcing and the general acceptance of new technological innovations such as use of nano particles and gene modified raw materials. From economic point of view, costs related to raw materials, energy, waste handling and possible investments are key issues. New functional properties can also bring added value for the packaging material.
The aim of the assessment is to find the critical sustainability aspects already during the development of the new materials and products. The assessment can guide the development towards more sustainable solutions and provide information on aspects that require further study.

References

WG1 – WG4

Development of bioactive packaging - EUREKA Project E! 4952 Blopackaging

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To prevent the development and spread of spoilage and pathogenic microorganisms via meat foodstuffs, antimicrobial and antioxidant packaging materials could be a potential alternative solution. Instead of mixing antimicrobial compounds directly with food, incorporating them in films allows the functional effect at the food surface – where the microbial growth is mostly found – to be localized. Antimicrobial packaging’s include systems such as active compounds binding (coating, impregnation or spraying) onto basic material will be performed in order to obtain cheap, but optimal functional effect at the food-material interface subjected two main packaging concepts: non – migratory and active release antimicrobial and antioxidant packaging.

The potential of these technologies are evaluated for the preservation of meat and meat products. The formulation’s bio-activity will be maintained with its synergistic antimicrobial and antioxidant properties, combining several plant antioxidants with polysaccharide chitosan.

This project intends to go beyond the synthesis-trial-error-synthesis routes. Finding the best procedures to prepare novel antimicrobial-antioxidant formulations for the project purposes will be paralleled by devising the best pre-treatment – activation of synthetic polymers in order to show two types of packaging concept: i) active release and ii) immobilization – non migratory antimicrobial packaging. An additional step will involve predicting and explaining the interactions between liquid formulations and synthetic polymers, that at the end, will be responsible for the adsorption and desorption processes on/from the packaging material and will define the practical packaging functionalities.

The proposed investigation will be a significant step forward in the development of non-toxic, bio-compatible, biodegradable, antimicrobial and antioxidant formulations, as a main novel component for different packaging materials. It will be developed under the coordination of the University of Maribor, partners: Institute “Jozef Stefan, Perutnina Ptuj D.D, Slovenia and “P.Poni” Institute of Macromolecular Chemistry, ICEFS COM SRL, LORACOM SRL – Romania

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In response to the increasing consumer demand for fresh and minimally processed foods, active packaging that efficiently contributes to maintain product quality during storage, has received considerable interest in the last years. Polyethylene and its copolymers are much popular materials for food packaging but they don't hold molecules of additives for a long time. At the same time it is well-known fact that polyethylene and its copolymers form clathrates (complex compounds) with organic compounds containing active functional groups. EVA copolymer is distinguished by its high clarity, puncture-resistance, impact strength and low heat-seal temperature. These properties make EVA a superior resin for many high performance flexible packaging applications and it is suitable for blown film extrusion.

Montmorillonites are used as structuring agent, as the large aggregated structures formed contribute to an entrapment of active agent molecule, a higher retention and also protect it during processing. The montmorillonite layer structure has pulled its use as antimicrobial and antifungal carrier. Nanocomposites based on ethylene vinyl acetate (EVA) copolymer, with different contents (e.g. 2.5 and 4 %) of various nanofillers (Cloisite, and Nanocor) were prepared. Modifications induced by the nanofiller incorporation on the properties of the obtained nanocomposites were followed by contact angle method and thermogravimetry. Evaluation of the surface energy evidenced the obtainment of more polar surfaces by Cloisite incorporation. This behavior leads to the decrease of the corresponding interfacial tension with blood and tissues, proving the induction of biocompatibility characteristics by some nanofillers. In the meantime, the used montmorillonites have a stabilizer role for EVA thermo-oxidative behavior.

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Chitosan/ polyvinyl alcohol blends for active food packaging

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There is an increasing interest to develop materials with film forming capacity and having antimicrobial properties which improve food safety and shelf-life. Antimicrobial packaging is one of the most promising active packaging systems. It is a promising and effective way to inhibit growing of certain bacteria in foods, but barriers to their commercial implementation continue to exist. Chitosan also represents interesting properties such as excellent film forming capacity and gas and aroma barrier properties at dry conditions, which makes it a suitable material for designing food coatings and packaging structures.

Poly(vinyl alcohol) has excellent film forming properties. Because of its good film forming and highly hydrophilic water-soluble with outstanding chemical stability it was blended different synthetic and natural polymers. It is used as a water-soluble film useful for packaging. Poly(vinyl alcohol) is completely water-soluble synthetic polymer and non-toxic. It is useful in many applications such as controlled drug delivery systems, recycling of polymers, film formation and packaging. Because of the good biological activities of chitosan, a combination of chitosan and PVA may have beneficial effects on the biological characteristics of blend films.

Present study deals with the preparation of blends of polyvinylalcohol (PVA) containing chitosan (CS) with different composition. The physico-chemical characterization was done by means of FT-IR spectroscopy, DSC, DMTA, optical microscopy and rheological measurements. The film forming ability of the blends was also confirmed by rheological tests, showing higher viscosity and improved viscoelastic properties in comparison with pure PVA. The obtained films, transparent and homogenous, presented enhanced mechanical properties and thermal stability.
Isolation of *Bacillus megaterium* strains for PHA production

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Production of polyhydroxyalkanoates (PHAs) has been investigated for more than eighty years but recently a number of factors like increasing the price of petroleum oil and public awareness of the environmental issues have become a notable driving force to extend research on biodegradable biopolymers. PHAs properties made them good candidates for the study of their potential in a variety of fields from biomedical to food packaging, textile and household material. Although some of these biopolymers are already produced at industrial scale, the price of this polymer is too high to compete with petroleum polymers. Because of this, the future trend is focused on development of more efficient and economical processes for PHAs production, isolation and purification. Until now all related studies for PHAs were based on experiments in which are used gram negative bacteria for production of these biopolymers. A method to isolate *Bacillus megaterium* strains which can produce PHAs has been developed in order to increase productivity of PHAs knowing that these bacteria named “megaterium” – means “big beast” has the largest cell diameter of any aerobic spore former (1.5 – 2 micrometers), generation time is less than 15 minutes and it grows on minimal medium without added growth factors. All strains were isolated from soil and granules of PHAs from the cells were emphasis by Nile Blue A staining. PHAs granules exhibited a strong fluorescence when stained with Nile blue A. Heat fixed cells were treated with 1% Nile Blue A for 10 minutes and were observed under fluorescence microscope at an excitation wavelength of 460 nm. Isolates of *Bacillus megaterium*, on agar medium after 48h incubation at 37°C were colonies with 1-3 mm diameter, translucent – whitish, round shape, slightly umbonate and with undulate edges. Most of the colonies of *Bacillus megaterium* were smooth, but some of them were slightly rough. All isolates were having rod cells with 2-3 micrometers diameter and were positive for catalase, gelatine liquefaction, starch hydrolysis, egg-yolk reaction and negative for phosphatase. The strains isolated were purified in order to be screened for PHAs production using different substrates like molasses, whey and cellulose hydrolyzed in the next research step.

References

Investigation of properties of plasma polymers deposited by RF magnetron sputtering of Nylon

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Application of RF magnetron sputtering of polymeric targets for the fabrication of thin films of plasma polymers has recently received increased attention as an alternative to commonly used PE-CVD technique. This is given by good scalability of this deposition process, high deposition rates and also by the possibility to tune the properties of the resulting deposits by selecting operational parameters such as target material, working gas mixture composition, pressure, discharge power etc. Especially, the latter is an aspect of paramount importance for the production of coatings needed for various applications ranging from deposition of bio-functional films, protective coatings or deposition of interlayers for further functionalization.

Presented study is focused on the investigation of nitrogen-rich thin films of plasma polymers prepared by means of RF magnetron sputtering of Nylon target. Nylon 6,6 (Goodfellow) target having 3 mm thickness and 81 mm diameter was sputtered by RF planar magnetron at a constant power of 40 W (13.56 MHz) in various working gas mixtures (Ar/N₂ and N₂/H₂) with an aim to determine influence of these parameters on the properties of deposited films. Concretely, the main intention of this contribution is (i) to demonstrate that this deposition process can be applied for coating of wide range of substrate materials (Si wafers, TiAlV alloys, glass, gold coated glass were successfully coated in this study), (ii) to determine the influence of the deposition parameters on the physical and chemical properties of fabricated films (iii) and finally to evaluate resistance of the coatings towards aqueous media or heat. These goals are achieved by the combination of various diagnostics methods (XPS, AFM, ellipsometry, QCM and water contact angle measurements) used for the characterization of the films in dependence on the substrate material, storage time, residence time in an aqueous media or on the exposure of the coatings to elevated temperatures needed for their sterilization. It has been found that working gas mixture has strong impact on the properties of the deposited films: plasma sustained in nitrogen-hydrogen mixture leads to the deposition of amino-rich coatings ([NH₂]/C approaches value of 0.2) on contrary to argon-nitrogen plasma, where the coatings are nitrogen-rich, but with markedly lower amino selectivity ([NH₂]/C in this case does not overcome value of 0.05). However, coatings prepared in N₂/H₂ were found to dissolve in liquids much more readily as compared to samples deposited in Ar/N₂ mixtures that are much more stable as well as resistant towards heat, which makes them more suitable for the real technological applications.

This work is a part of the research plan MSM0021620834 financed by the Ministry of Education of Czech republic, the GAUK 110-10/251265 and was partly supported by the Grant Agency of the academy of Sciences of the Czech Republic under contract KAN101120701.
Shear-Induced Crystallization of Isotactic Polypropylene (iPP) based Nanocomposites with Montmorillonite (MMT)

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The processing operations, such as extrusion, injection molding, fiber spinning, etc., the molten are exposed to varying levels of flow fields (elongation, shear, mixed) \cite{1}. The flow fields induce different degree of anisotropy to the polymer melt, which modifies the nucleation and crystallization behaviour. In the field of polymer nanocomposites the study of crystallization and morphology in condition close to that of the industrial process is still at an early stage and his study could give important information to the industrial production of iPP/MMT nanocomposites. The nanocomposites are recently a subject of the intense investigation as a result of the industrial importance and of manifold property enhancements. In particular the addition of MMT into iPP is expected to further improve stiffness, strength and barrier performance. As a result of surface polarity mismatch between iPP and MMT it is necessary to compatibilize them by modifying one of the two phases (the MMT or the matrix) or adding a third component as compatibilizer. In this work it was used a purified MMT modified with a high content of quaternary ammonium salt (Dellite G67) and an unmodified MMT (Dellite HPS) as for comparison.

Crystallization under shear was studied by In-situ synchrotron small-angle X-ray scattering at the Elettra synchrotron light source (Trieste-Italy) by using a small volume shear cell expressly designed to perform in situ experiments where the rheometer must be held in a vertical position \cite{2}. The samples were first heated and held at 215°C for 10 minutes and then cooled at 10°C/min to the chosen shear temperature. A brief impulse of step shear of 10s\textsuperscript{-1} for 100 s at selected temperatures (160, 170, 175, 180,185 and 190°C) was applied. After the shearing the samples was cooled at 20°C/min to room temperature. The acquisition time for each image was 10s with an interval of 5s for data transfer between the adjacent images. The results indicate that the two MMT influence differently the crystallization process and the anisotropy of iPP.

References

Characterization of mLLDPE/LDPE blown films

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Polyethylene blown films are the most important polymer products consumed today (1) and are mainly used in the packaging area, where the optical properties, such as haze and transparency, are key issues in the applications.

In the family of the polyethylenes, metallocene linear low-density polyethylene (mLLDPE) presents superior physical and mechanical properties as compared to polyethylenes with the same average molecular mass produced using conventional catalysts. However, due to its molecular characteristics (narrow distribution of molecular mass with short chain branching and homogenous distribution of the chain branching), the processability of mLLDPE is poor (2-3); so a high melt pressure and a high motor load during the extrusion are required.

Moreover the optical properties of mLLDPE blown films could be not satisfactory for the user if development of superstructures (spherulites and sharkskin structures, row-nucleated oriented structure) is promoted during the blowing causing surface roughness and discontinuities in bulk in final film.

One way to overcome the disadvantage of poor processability and optical properties consists in adding to mLLDPE a certain amount of low-density PE (LDPE) to have PE material with wider molecular mass distribution (MWD) and with improved processability without losing the superior mechanical properties of mLLDPE.

Wide and small angle X-ray measurements were carried out in order to study the crystal structure, the orientation of the crystals and of lamellae respectively in the blown films in dependence on composition. Films have been characterized by studying mechanical and barrier properties. The results showed that the blend films keep the same mechanical properties of the neat mLLDPE with higher elongation and stress at break respect to LDPE. The addition of LDPE to mLLDPE has the effect to decrease the water vapour permeability respect to the neat mLLDPE, whereas the oxygen permeability increases.

References
Silica/acrylate and silica/epoxy hybrid materials through the sol gel method

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Organic /inorganic hybrids have, recently, attracted great interest for application in a number of areas including optics, electronics, mechanics, energy, environment, biology, medicine, catalysis, sensors and so on. A major problem is to avoid segregation and aggregation of the dispersed inorganic phase. In order to obtain nanometric domains uniformly distributed into the polymer matrix the need is recognized to promote their compatibilization.

Well dispersed silica nanoparticles into poly(2-hydroxyethylmethacrylate) (pHEMA) and poly-glycidyl ether of bisphenol A (DGEBA) was obtained through, respectively, “in situ” and “extra situ” sol gel method.

In the first case compatibilization was obtained through in situ hydrolysis and polycondensation of mixtures of tetraethylortosilicate (TEOS) and methacrylate monomers bearing an alkoxyisilyl unit, prepared by Michael addition of 2-hydroxyethylmethacrylate(HEMA) to 3-aminopropytriethoxysilane (APTS) and successive acrylate polymerization.

In the second case silica nanoparticles obtained by mixtures of TEOS and APTS, grafted with di-glycidyl ether of bisphenol A through the APTS amino group, were used to obtain well dispersed silica nanoparticles into poly-glycidyl ether of bisphenol A.

In both cases the use of APTS was fundamental to promote coupling and avoid segregation and aggregation of the dispersed inorganic phase.

The effect of the dispersion on the composite properties, particularly the thermal ones like the glass transformation temperature and thermal stability, was studied. In the case of epoxy, the effect of the nanoparticles on the cure kinetic was, also, studied through thermoanalytical techniques.
Characterizing PSI-co-PEG block copolymer

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Poly(ethylene glycol) (PEG) is generally considered inert and it is used in medicine, in cosmetics, ointments, suppositories, in ophthalmic solutions and sustained-released oral pharmaceutical applications. PEG it is also utilized as plasticizers, solvents, water-soluble lubricants for rubber molds, wetting or softening agents, antistatics in the production of urethane rubber, components of detergents, etc. Food and Drug Administration from USA regulates PEGs for employing in adhesives compositions as components of articles intended for use in packaging, transporting, or holding food (PEG 200-6000); in resinous and polymeric coatings used as the food-contact surfaces of articles intended for use in producing, manufacturing, packing, processing, preparing, treating, packaging, transporting, or holding food; as a component of the uncoated or coated food-contact surface of paper and paperboard intended for use in producing, manufacturing, packing, transporting, or holding dry, aqueous and fatty food.

Studies concerning the poly(aspartic acid) (PAS) toxicity indicate that polymer is nontoxic and environmentally safe. PAS has (bio)degradability and high water absorbency and has application in food packaging materials such as freshness-retaining materials for food trays, and drip absorbent sheets; materials for use during transportation, such as cold insulators, and water absorbent sheets for use during the transportation of fresh vegetables.

The block copolymers were synthesized by polycondensation starting from poly (succinimide) and PEG (with different molecular weights) in the presence of manganese acetate as catalyst. The characterization of the block copolymer it is presented. The characterization of the synthesized macromolecular compounds from the viewpoint of their thermal stability and suprastructure is presented. Studies concerning the evolution of the hydrodynamic radius and zeta potential in function of pH have been performed.

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Microbial aspects of Eco-sustainable food packaging

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In the development of new Eco-sustainable food packaging material based on polymer nanomaterials the microbial aspects have to be addressed. The use of biodegradable materials or the incorporation of new components into the packaging material could support the growth of microorganisms on the material or in the interaction layer between packaging material and food. An accurate assessment of
microbial growth in relation to different types of foods is therefore important. Also in the development of new materials with build in antimicrobial effect it is of great importance to get an accurate assessment of the effect towards the microorganisms associated to the product in mind and to get accurate measurements of the release of active components in liquid and gas face and to access how these concentrations will affect the microorganisms associated to the product.

The standard method for testing for microbial growth on polymer materials, ASTM G21-96, will not give sufficient good evaluation of fungal survival and growth development. If the ASTM standard method is used most biobased material would be rated as unsuitable for food packaging. But, as the use of biobased material may be limited to few specific product groups, test methods relevant for that food group and the use of food associated microorganisms are needed. A new method giving a much more detailed evaluation of fungal growth on polymer surfaces have therefore been developed\(^1\). Starch based materials had generally unacceptable performance in our test, whereas PLA and PBH seemed to be promising material for food packaging application, as no significant growth of fungi was detected.

Testing for antimicrobial effect is a challenge as it both has to address the antimicrobial effect from volatiles if the components are intended to work through the gas phase in the package or in liquid phase if they should work through the liquid phase or from contact to the food material. Also it is important that all the microorganisms associated to the food product are tested. This can be tested by assessing growth of relevant microorganisms when in contact with the material or when cultured on a growth media in a closed container containing the volatile antimicrobial compound or the film containing the volatile antimicrobial compound\(^2\). Important additional information can be gained by simultaneous measurement of the concentration of active components in the gas phase by GC measurements\(^3\). A rapid alternative is the use of impedance microbiology to measure the metabolic activity in a growth substrate or food when in contact with the antimicrobial material. This method has previously mostly been used for testing sanitations processes but has a great potential in food packaging.

References