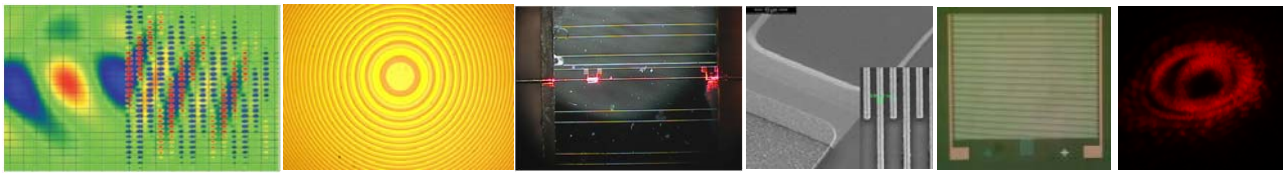
Laboratorul de Micro si Nanofotonica – L3



http://www.imt.ro/organisation/research%20labs/L3/index.htm

MISIUNE

L3 are ca misiune cercetarea stiintifica si dezvoltarea de dispozitive cu aplicatii in micro/nano fotonica in domeniul spectral UV-Vis-IR.

1. **Modelare, simulare, CAD pentru structuri micro si nano-fotonice**
   - Dispozitive si circuite integrate optoelectronice;
   - Circuite fotonice integrate ;
   - Componente de microoptica si elemente optice diffractive;
   - MOEMs;
   - Structuri plasmonice
   - Componete micro-optice; elemente optice difractive.
2. **Caracterizari optice si electrice pentru materiale si dispozitive**
   - **Noi materiale pentru micro-si nano-fotonica** (nanocompozite hibride cu proprietati optice controlate, oxizi semiconductori transparenti, grafena, puncte cuantice)**, noi procese si dezvoltare de dispozitive**
   - **Componente micro-nano-fotonice pentru senzori** (structuri plasmonice, componente microoptice, DOE, structuri ptofluidice, biosenzori optici)

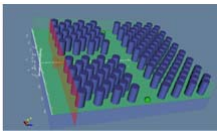
Echipa L3 are o expertiza multidisciplinara in Optoelectronica/Electronica, Fizica si Chimie fiind compusa din 6 cercetatori seniori, 3 post-doctoranzi si un doctorand. Laboratorul este coordonat de catre Dr. Dana Cristea (dana.cristea@imt.ro)

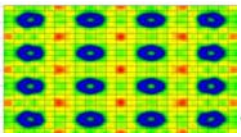
DIRECTII NOI DE CERCETARE

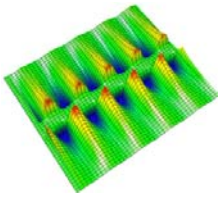
- Optoelectronica organica (incluzand si dispozitive pe baza de nanocompozite grafena-polimer);
- Electronica transparenta.
- Dispozitive si componente fotonice si plasmonice, metamateriale si metasuprafete
- Vortexuri optice si comunicatii optice prin spatiu liber.

Facilitati

1. **Modelare si simulare:**
   - ***Opti FDTD 12.2.1*** – proiectare, modelare, simulare, CAD a componentelor fotonice pasive si neliniare prin metoda FDTD (Finite-Difference Time-Domain)
   - ***OptiBPM 11.0*** - proiectare, modelare, simulare, CAD a ghidurilor optice si a circuitelor fotonice integrate complexe prin metoda BPM (beam propagation method).
   - ***OptiGrating,* LaserMod**
   - **3Lit** – design pentru elemente micro-optice 3D.
   - **Zemax** – design optic.

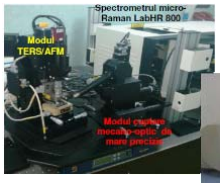


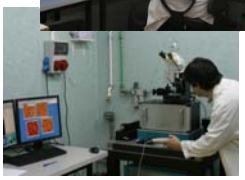




2. **Tehnologie:**
   - glove box pentru prepararea si depunerea nanocompozitelor si straturilor organice

3. **Caracterizare:**
   - ***Spectrofotometre*** *pentru domeniul UV-VIS-NIR si IR;*
   - ***Elipsometru spectroscopic***
   - ***Sistem complex*** *rezultat prin cuplarea* ***modulului TERS/AFM*** *la* ***spectrometrul micro-Raman – LabHR 800*** *pentru analiza nanostructurilor carbonice si oxidice (nanotuburi, nano/micro fire, grafene,nanocompozite*).
   - ***Alpha300 S System*** *–*microscopie de baleiaj in camp apropiat (SNOM), microscopie confocala , microscopie de forta atomica, spectrometrie Raman
   - ***Tensiometru Optic*** *Theta (KSW Instruments)*
   - *Montaj experimental pentru caracterizarea optoelectrica a dispozitivelor in UV-Vis-NIR*





PROIECTE RECENTE

Internationale

- **MIMOMEMS**- European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors, REGPOT call 2007-1, Contract no. 202897, - Contact Dr. Dana Cristea, http://www.imt.ro/mimomems

- FlexPAET- Flexible Patterning of Complex Micro Structures using Adaptive Embossing Technology**,** IP, NMP, Contact Dr. Dana Cristea http://www.flexpaet.eu/

Nationale

- ROSA (Romanian Space Agency)
  - Fotodetectoare pe straturi subtiri- noi concepte si studii privind utilizarea in aplicatii aerospatiale -
    coordonator Dr. Dana Cristea;
  - Bolometre in IR mijlociu si indepartat pentru aplicatii spatiale – coordonator Dr. Mihai Kusko
- Cooperare, PNCD II
  - Nanostructuri 1D si 2D pe baza de ZnO si procese tehnologice innovative pentru integrarea lor directa in dispozitive de sesizare gaze si de detectie a radiatiei UV NANOZON, - coordonator Dr. Munizer Purica, http://www.imt.ro/nanozon/
  - Dezvoltare tehnici de litografie soft pentru micro-nanofotonica, LISOFT, 2007-2010 - Coordonator Dr. Paula Obreja, http://www.imt.ro/lisoft/
  - Procese si dispozitive pe baza de straturi subtiri oxidice si polimerice pentru electronica si optoelectronica transparenta, ELOTRANSP, Coordonator Dr. Munizer Purica, http://www.imt.ro/ELOTRANSP
  - Comunicatii optice securizate de mare capacitate prin spatiul liber, bazate pe holograme generate pe computer, HOLOCOMM - Coordonator Dr. Cristian Kusko; http://www.imt.ro/holcomm
  - Spectrometru compact in infrarosu, COSPIR – Coordonator Dr. Mihai Kusko, http://www.imt.ro/cospir/
- IDEI, PNII
  - Arhitecturi moleculare multifunctionale pentru electronica organica si nanotehnologii- studiu teoretic si experimental - coordonator Dr. Dana Cristea, http://www.imt.ro/amelor/
- MNT ERA-NET projects
  - Nanostructuri de ZnO multifunctionale: de la materiale la o noua generatie de dispozitive, Contact Dr. Munizer Purica (munizer.purica@imt.ro)
- Cooperare PNCDI III
  - PNIII- PET - Transfer tehnologic pentru cresterea nivelului de securizare si a calitatii etichetelor holografice, - Contact Dr. Dana Cristea
  - PNIII PED - Tehnologie de realizare fotodetectoare multispectrale cu aplicatii in sistemele optice de observare si supraveghere – Coordonator Dr. Dana Cristea

REZULTATE OBȚINUTE

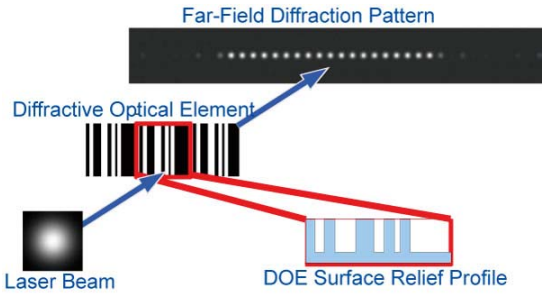
Micro-optica difractiva - Tehnologii

- **Elemente de micro-optica difractiva**

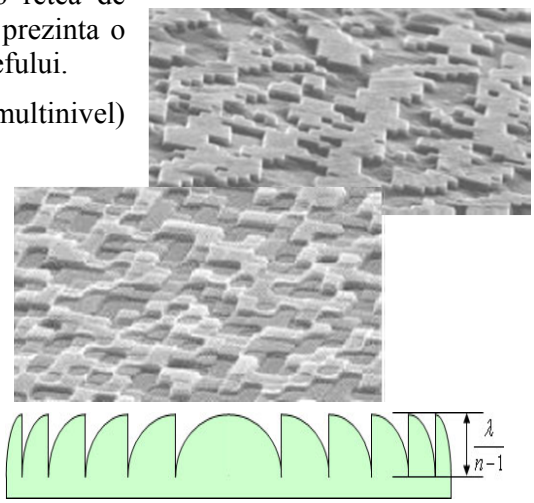
Dr. Mihai Kusko (mihai.kusko@imt.ro)

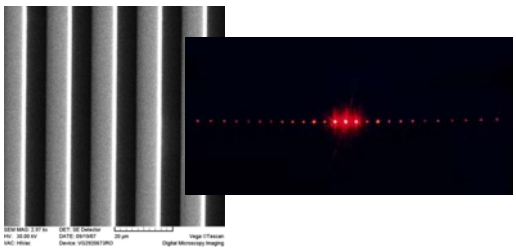
Micro-optica difractiva se bazeaza pe fenomenul de interferenta si prezinta avantajul ca necesita dispozitive planare care pot fi realizate prin tehnici litografice si de microprelucrare similare cu cele utilizate in micro si nano-electronica

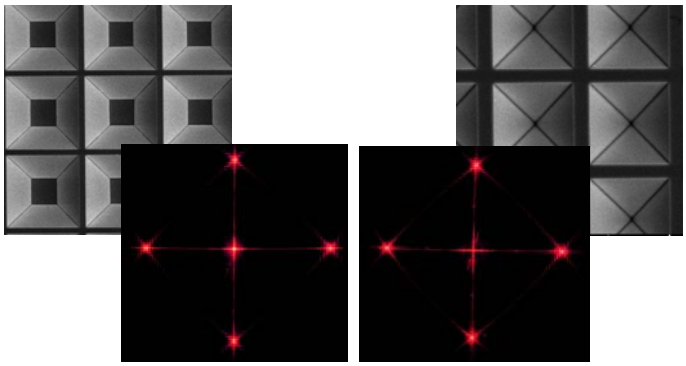
Elementele optice difractive (DOE) sunt structrui micro.nano-optice care transforma un fascicul laser de intrare intr-o distributie luminoasa specifica utilizind fenomenul de difractie.



- Suprafata de difractie a unui DOE consta dintr-o retea de elemente optice micro sau nanostructurate care si prezinta o variatie locala 2D a perioadei si o variatie 3D a reliefului.
- Variatia reliefului – in trepte (structuri binare sau multinivel) sau continua
- DOE permit practic obtinerea oricarei distributii de intensitate a fasciculului emergent
- Aplicatii: componente pentru comunicatii optice(elemete de cuplaj, splitere, etc.), procesarea materialelor cu laserul, spectroscopie, senzori, elemente de securitate.

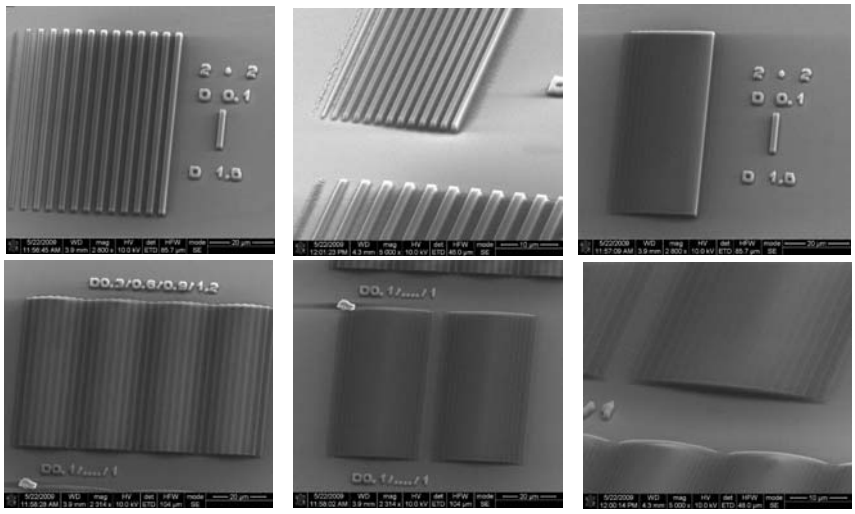






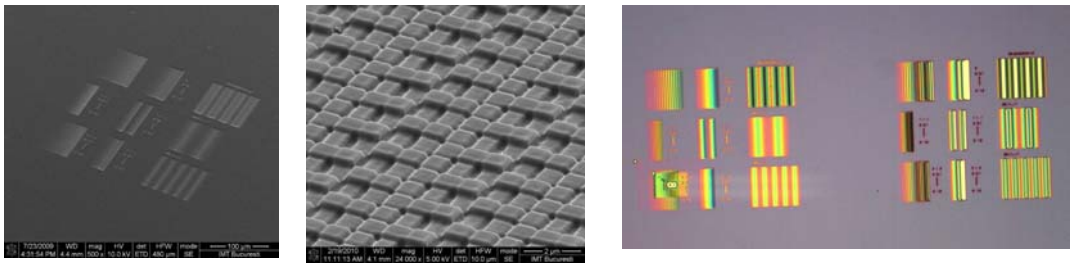
- **Litografie 3D in rezisti cu contrast redus - SU 8**

Dr. Dana Cristea (dana.cristea@imt.ro)



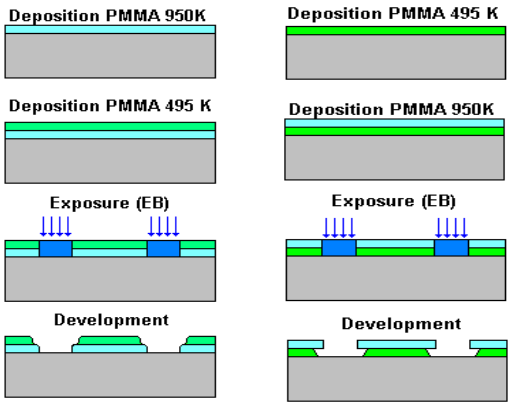
- **Litografie 3D in rezisti cu contrast redus – PMMA**

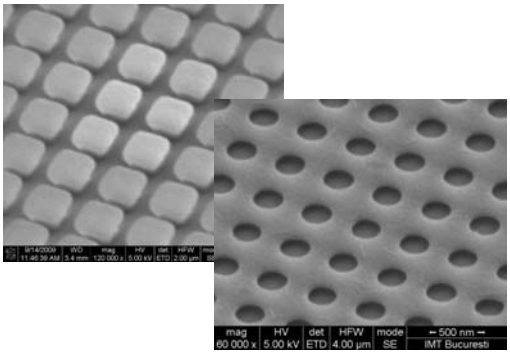
Dr. Dana Cristea (dana.cristea@imt.ro)



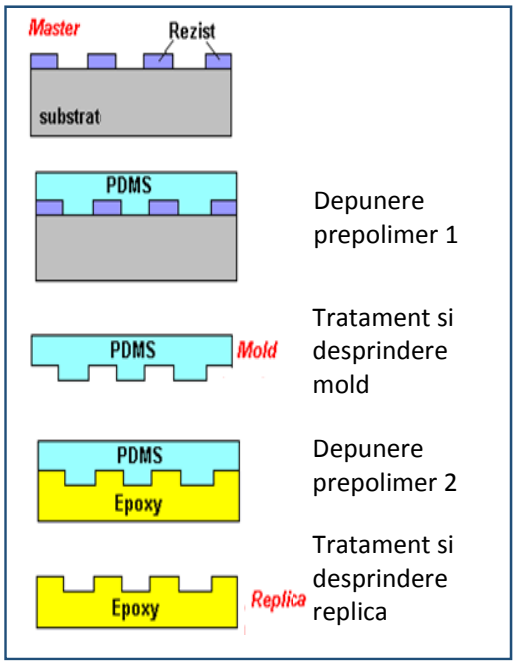
- **Litografie 3D in straturi duble de rezisti**

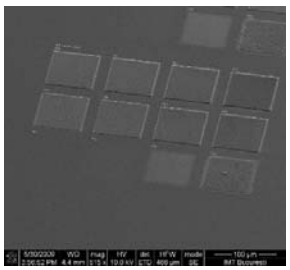
Au fost utilizati doi rezisti cu rate de corodare diferite.



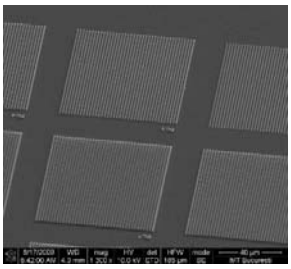


- **Replicare a unor mastere cu profil 2D/3D - Paula Obreja (paula.obreja@imt.ro)**

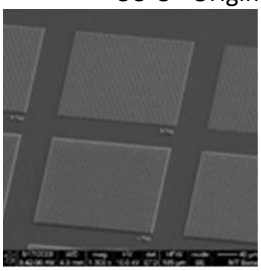




PDMS – Copie negativa

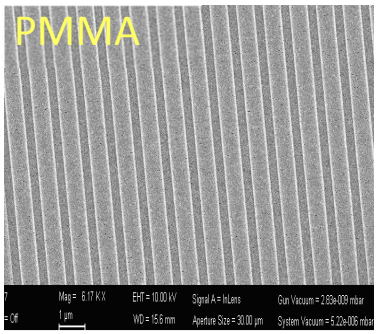


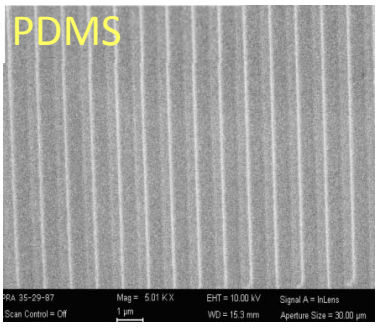
SU-8 - Original

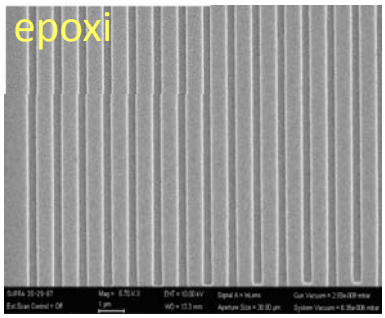


Epoxi – Copie pozitiva

- Retele de difractie (linia de 200 nm replicate) in rasina epoxidica

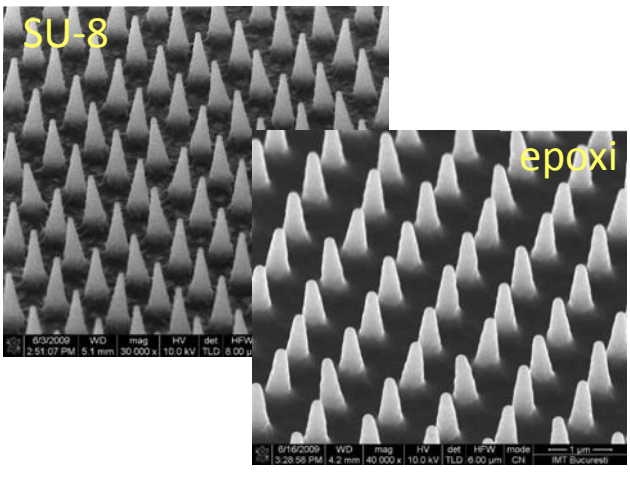


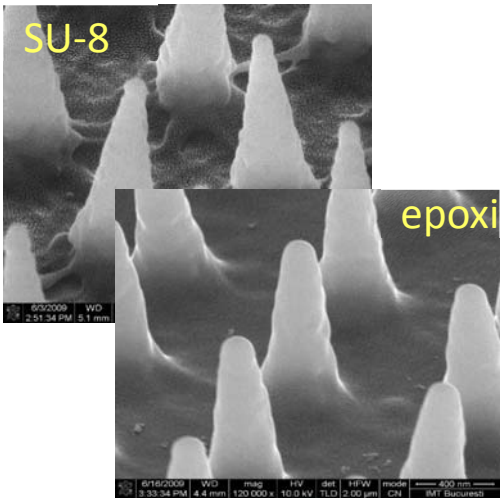




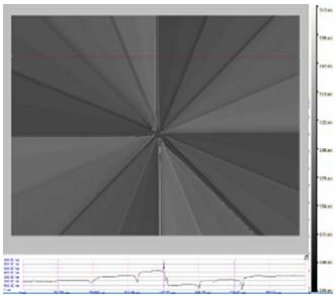
Original → Copie negativa → Copie pozitiva

- Replica in rasina epoxi a unor originale realizate in SU-8 (s-a utilizat o matrita de PDMS-copia negativa)

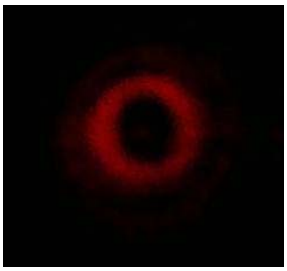




- **Structuri multinivel obtinute prin etape succesive de litografie si corodare - *Comunicatii optice securizate de mare capacitate prin spatiul liber, bazate pe holograme generate pe computer – Proiect PN-II-PT-PCCA 2011-2015* – Dr. Cristian Kusko** (cristian.kusko@imt.ro)



Imaginea de interferometrie in lumina alba a unui element optic difractiv cu 8 nivele (3 masti) care genereaza un vortex optic cu ordinul m=4.

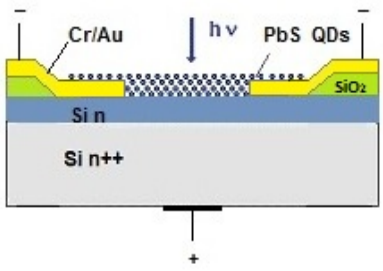


vortex optic de ordinul m=4

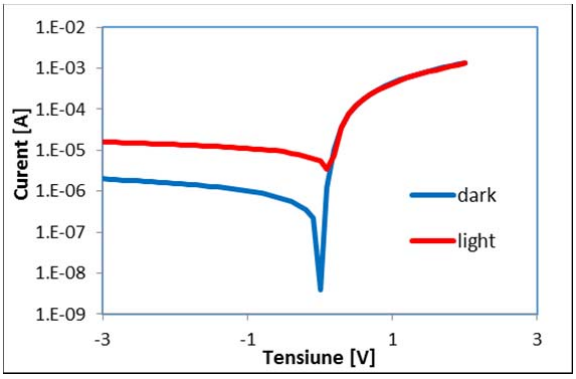
interferenta a doua vortexuri cu m=4 si m=-4

Fotodetectoare cu raspuns imbunatatit in IR - **Fotodetectoare pe straturi subtiri - noi concepte si studii privind utilizarea in aplicatii aerospatiale Proiect STAR - Dr. Dana Cristea** dana.cristea@imt.ro

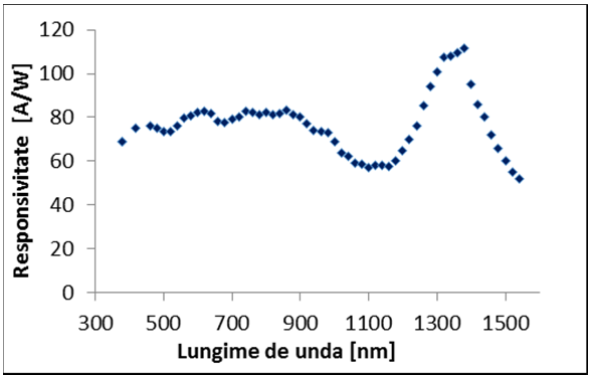
Fotodetector hibrid PbS/Si-secțiune realizate prin depunerea de straturi subtiri de puncte cuantice de PbS (PbS QDs) peste structuri Schottky Au/Si.



Sectiune prin structura si modul de polarizare



Caracteristicile I-V la intuneric si iluminare



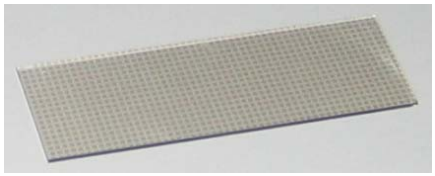
Responsivitatea spectrala (V = 1V, Popt ~25 nW)

Responsivitati in domeniul 60-100 A/W pentru. λ = 350-1550 nm

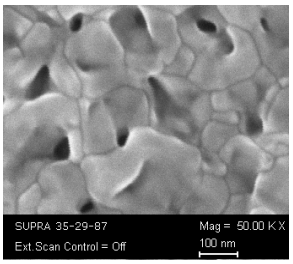
Senzori pentru radiatia UV cu factor de rejectie mare a radiatiei vizibile pe baza de straturi subtiri oxidice nanostructurate

Contact: Dr Purica Munizer (munizer.purica@imt.ro)

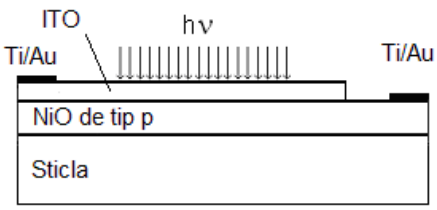
Structurile de detectie pentru radiatia UV cu heterojonctiune Schottky transparenta s-au realizat pe substrat transparente (sticla, cuart, substrat flexibil de PET) utilizand straturi subtiri de semiconductoare oxidice de banda larga (> 3eV) de tip n si p: p–NiO, n-ZnO, n-ITO, p-CuO.



Structura cu heterojonctiune transparenta NiO(p)/ITO(n)



Imagine SEM a stratului de NiO nanostructurat

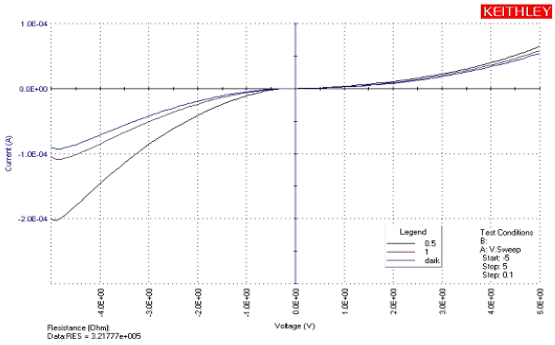


Reprezentare schematica a sectiunii prin structura

$\lambda < 350$ nm - I ~300 µA

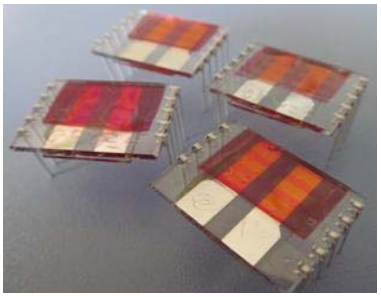
$\lambda > 400$ nm - I ~ I_{dark}

→ absorbtia radiatiei UV are loc in stratul de NiO si colectarea purtatorilor in jonctiunea Schottky transparenta



Dispozitive pe baza de nanoparticule de ZnO

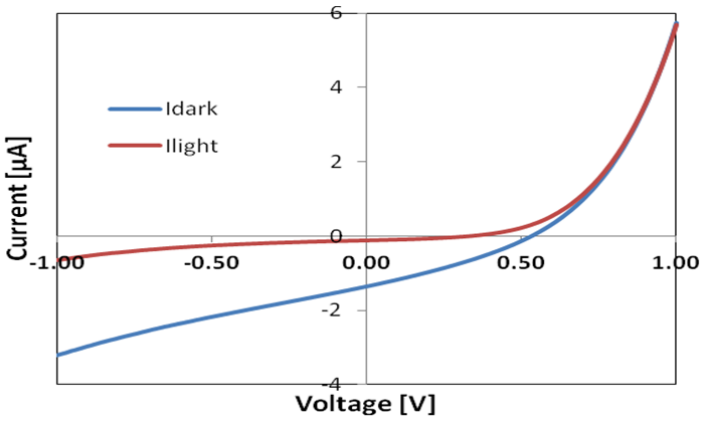
Contact: Paula Obreja (paula.obreja@imt.ro)



Au fost obtinute componente si dispozitive experimentale de tip heterojonctiuni de volum (BHJ) sensibile la iluminare atit in vizibil cat si in UV.

Structurile experimentale obtinute de tip:

- ITO/ZnO/P3HT:PC61BM/PEDOT:PSS/Ag si
- ITO/ZnO/P3HT:PC61BM/MoO3/Ag

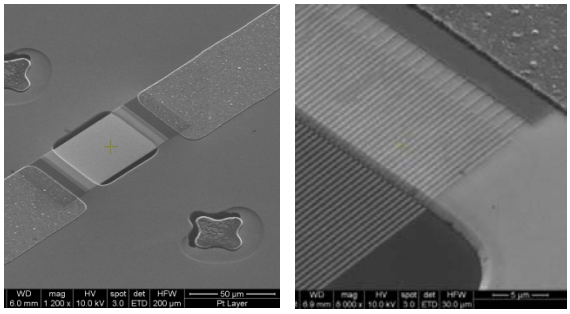


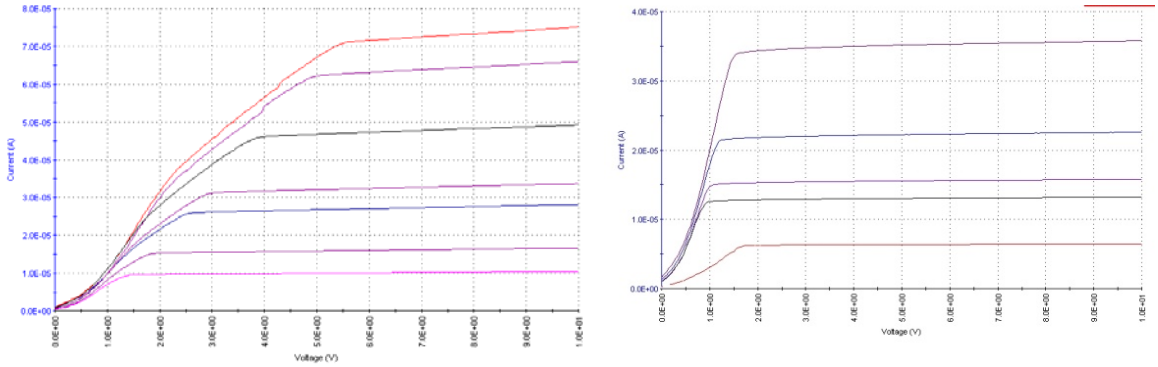
Caracteristicile I-V pentru un dispozitiv fotovoltaic de tip ITO/ZnO/P3HT:PC61BM/MoO_3/Ag cu strat de ZnO de 40 nm grosime si arie de 4,5 mm^2

Fotodetectoare rapide si eficiente de tip MSM cu electrozi transparenti submicronice pe straturi subtiri de materiale semiconductor

Contact: Elena Budianu (elena.budianu@imt.ro)

Fotodetectoare de tip MSM cu electrozi interdigitati si transparenti de 150 nm si 300 nm latime din straturi oxidice transparente si conductive de tip n - ITO, ZnO pe substrate ultrasubtiri de siliciu (~ 2µm plachete SOI).





a) b)

Caracteristicile I-V pentru diverse nivele de iluminare in UV (365 nm) a MSM cu electrozi de: a) 150 nm latime; b) 300 nm latime