

UV-curable materials composition

Polymerizable surface active monomer

Diurethane dimethacrylate
(№436909 ALDRICH, UDMA)
Isodecyl acrylate (№408956
ALDRICH, IDA)

SiO₂ nanoparticles, covered by organic shell + AuNP

Dodecanethiol functionalized gold nanoparticles, 5nm
(Nanoprobes, №3014, AuNP)
SiO₂ nanoparticles, 7 nm (Aldrich №066K0110)

UV- Polymerizable nanocomposite

Requirement:

- high nanoparticles concentration; same time
- keeping of polymer's properties: transparency, homogenously, solubility, plasticity and processability.

View 2 x 2 um surface of nanocomposite. Formation of spheres around each nanoparticle well visible.

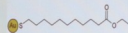
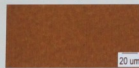
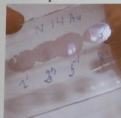


BisA/2Car (3/7) + ZnO nanoparticles (wt.%)

Properties of gold nanoparticles

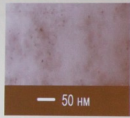
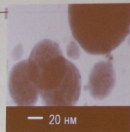
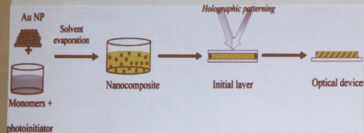
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- Stability;
- Gold nanoparticles are acceptors of electrons, also they can be catalyst of reaction;
- Plasmon resonance, which depends on size of nanoparticles and their shapes.



Goldenberg L. M. et al. Holographic composites with gold nanoparticles: nanoparticles egregation // Chemistry of Materials. – 2008. – T. 20. – №. 14. – C. 3

Synthesis of polymer-based nanocomposites with AuNP

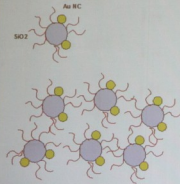


Goldenberg L. M. et al. Holographic composites with gold nanoparticles: nanoparticles egregation //Chemistry of Materials. – 2008. – T. 20. – №. 14. – C. 4

Gold - SiO₂ transparent nanocomposites

Au-SiO₂- monomer compositions

monomer	SiO ₂ wt%	initiator	AuNPs wt%
AmAc	14	0.2 wt% In2 or 0.5 wt % CQ	0.30
UDMA	10	0.2 wt% In2 or 0.5 wt % CQ	0.1 - 0.55
UDMA	26	0.2 wt % In2	0.1 - 0.55
UDMA/ AmAc= 70/30	10	0.2 wt% In2	0.1 - 0.3



Gold nanoparticles were deposited on SiO₂ nanoparticle surface and these combination were mixed in surface active monomers mixture.

Preparation of Au-monomer system.

Matrix material UDMA was mixed 3 hours in a magnetic mixer with initiator - camphorquinone (0.5 wt% concentration) and 1 ml solution of AuNPs in toluene with concentration 0.50 wt % was added to the monomer. Compositions of Au-SiO₂- monomer composites are presented in Table 1. Silicon oxide nanoparticles were added to the above mentioned monomers and the homogeneous solution was prepared by UHF - dispersion at 55 °C during 24 hours.

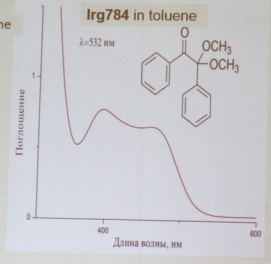
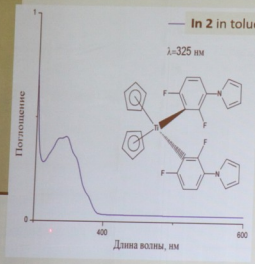
Nanocomposites

Nanocomposite	Composition
14a-0.5	UDMA+IDA+10macc.%SiO ₂ +In ₂
14Au-0.5	UDMA+IDA+10macc.%SiO ₂ +Au+In ₂
30a-0.5	UDMA+IDA+10macc.%SiO ₂ +Irg784
30Au-0.5	UDMA+IDA+10macc.%SiO ₂ +Au+Irg784

Nanocomposites were prepared by mixing of SiO₂ nanoparticles in UV-curable monomers mixture with absorption in its surface of gold nanoparticles. Ultrasound stirring of nanocomposite as well as interaction between UDMA and SiO₂ nanoparticles surface will result of preparation of well dispersed homogenous transparent nanocomposite.

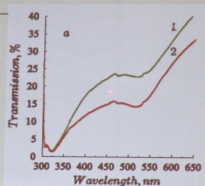
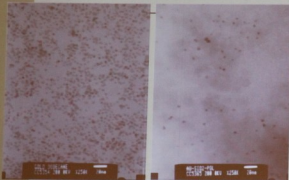
Polymerization initiators

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Gold nanoparticles stabilized in monomers and polymer



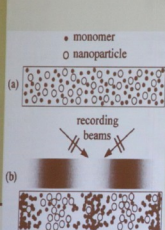
- TEM pictures of AuNPs in polymer matrix: UDMA/ 0,2 wt% AuNPs/ 10% SiO₂ NPs (in the left);
- 0,2 wt% Au NP/UDMA with SiO₂ (in the right).
- It is well visible that homogenous dispersion form only after deposition of AuNPs on SiO₂ nanoparticle surface previously (left)

- Optical transmission spectra : for 10 wt % SiO₂ - 0,3 wt% AuNPs-AmAc nanocomposite (1- monomer, 2-polymer).

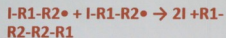
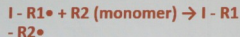
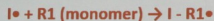
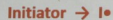
J. Burunkova¹, I. Denisjuk¹, C. Hegedus, L. Daroczi, S. Charnovich, S. Kokenyesi // PHYSICS AND CHEMISTRY OF SOLID STATE V. 14, № 4 (2013) P. 847-850

Principle of the holographic recording of polymer-based nanocomposites and mechanism of the polymerization

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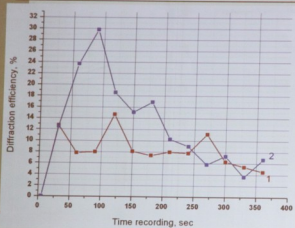


Distribution of components in nanocomposite a) before and b) during holographic recording.

Suzuki N., Tomita Y., Kojima T. Holographic recording in TiO₂ nanoparticle-dispersed methacrylate photopolymer films //Applied physics letters. – 2002. – T. 81. – №. 22. – C. 4121-4123.

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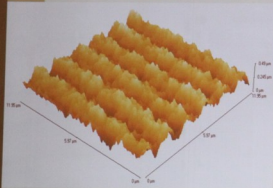
Change of diffraction efficiency at AuNP addition.



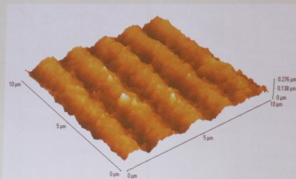
- Curve 1 - without AuNP
- Curve 2 - with AuNP.

Surface grating with and without AuNP.

With AuNP

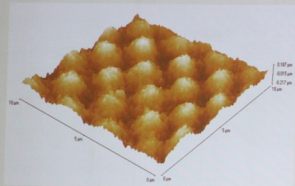


Without AuNP



- Surface grating modulation dependence on presence of AuNP in composition

Four beam writing of 2D photonic crystal



- 2D grating on surface of nanocomposite

Conclusion

- **Nanocomposite based on UV-curable monomers with gold nanoparticles stabilized by SiO₂ nanoparticles is new transparent optical material with high AuNP concentration.**
- **By mean of light induced nanoparticles redistribution it is possible to writing hologram on this material and to produce photonic with plasmon effect on gold nanoparticles.**