



Institute for Color Science and Technology
English Catalogue

2020

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Institute for Color Science and Technology

Institute for Color Science and Technology (ICST) which is affiliated to the Ministry of Science, Research and Technology, was inaugurated in July 1997 to develop knowledge and technologies in all areas related to Color, Colorants, Paint and Coatings. Since ICST has the effective cooperation with universities, research and industrial centers, it successfully trouble-shoots color, colorant, paint and coatings industries.

Research Faculties

1. Faculty of Surface Coatings and Novel Technologies

- Department of Surface Coatings and Corrosion
- Department of Resins and Additives
- Department of Nano Materials and Nano Coatings

2. Faculty of Colorants

- Department of Organic Colorants
- Department of Inorganic Pigments and Glazes
- Department of Environmental Research

3. Faculty of Color Physics

- Department of Color Imaging and Color Image Processing
- Department of Color Control and Color Reproduction
- Department of Printing Science and Technology

Department of Surface Coatings and Corrosion



Department of Surface Coatings and Corrosion, equipped with state-of-the-art instruments, covers all fields related to organic coatings (high solid, powder, water-borne and radiation curable coatings), i.e., surface preparation and engineering, corrosion protection methods and theory, smart and environmental friendly coatings, preparation technology, application methods and quality control of surface coatings.

Research activities

Design, formulation, optimization and modification of different types of surface coatings and related processes, study of properties of different types of surface coatings (protective, decorative and functional) on different types of substrates such as metallic, concrete, wood, paper, plastics, fundamental studies of anti-corrosion properties of surface coatings and corrosion inhibitors.

Customer services

Our team offers an extensive range of comprehensive services including:

- 1) Simulation of the corrosive media to examine the coating performance in service life
- 2) Performing coatings testing including
- 3) Reference laboratory for quality control of water, oil and gas transmission line coatings
- 4) Providing Advice on setting up laboratories and color production lines
- 5) Certifying coatings quality
- 6) Formulating desired coatings based on customers' demands
- 7) Troubleshooting

Department of Surface Coatings and Corrosion

Facilities

Equipment of Surface Coating and Corrosion Group		
Row	Property	Test
1	Primary	Surface/interfacial Tension-Contact Angle-Powder Wetting Angle-Solid/Volume Content-Zinc Content-Viscosity Analysis-Particle Size-Hiding Power-Drying Time-Preparation Devices(Homogenizer-Ultrasound-Mixer-Three role mills)
2	Anti-corrosion	EIS-DC-Noise-Cathodic Disbondment-Salt Spray-Humidity Chamber-Cyclic Corrosion Tester-QUV
3	Appearance, Physical and Mechanical	Pendulum Hardness-Micro Hardness-Pencil Hardness-Pull off-Cross Cut- Bending-Thickness-Turbidity-Tensile(Elevated Temperature)-Melt Floe Rate-Cupping-Wave Scan-Gloss-Roughness-Impact-Abrasion Resistance-Washability-Chipping Resistance-Solvent Resistance-Scratch Resistance-Thermal Stability-Oil Absorption-Light Resistance-Freezing Resistance-Electrical Resistance

Department of Surface Coatings and Corrosion

Distinguished projects

Cr (III) conversion coating on steel

- Layered double hydroxide (LDH) conversion coating on aluminum with subsequent silane coating
- LDH decorated nano-silica for corrosion inhibitor loading
- Graphene oxide (GO) encapsulated with polydopamine (PDA@GO)
- GO as Pr(III) container (Pr(III)@GO)
- Silane coating containing oxidized Carbon Nano-Tubes (CNTs) and their water uptake calculation based on CPE element
- Enhancement of UV resistance polyurethane coating (PU) with reduced GOs (rGOs) obtained with different methods
- Plants extracts and their use as corrosion inhibitor solely or in combination with inorganic cations providing synergistic inhibition effect
- Halosite as container for organic in inorganic corrosion inhibitors
- Mesoporous silica as container for organic in inorganic corrosion inhibitors
- Carbon hollow spheres (CHSs) as container for organic inhibitor
- Carbon hollow spheres (CHSs) as container for film forming agents for application in self-healing coatings
- Metal organic frameworks (MOFs) as container for organic inhibitor
- MOFs decoration on GO
- Epoxy-silicone coatings with high weathering and corrosion resistance

Members



Reza Amini
Assistant Professor
amini-re@icrc.ac.ir



Saeed Bastani
Associate Professor
bastani@icrc.ac.ir

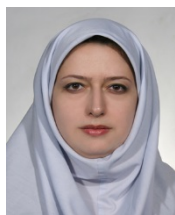


Pooneh Kardar
Assistant Professor
kardar@icrc.ac.ir



Mohammad Mahdavian
Associate Professor
mahdavian-m@icrc.ac.ir

Department of Surface Coatings and Corrosion



Shadi Montazeri
Assistant Professor
montazeri-sh@icrc.ac.ir



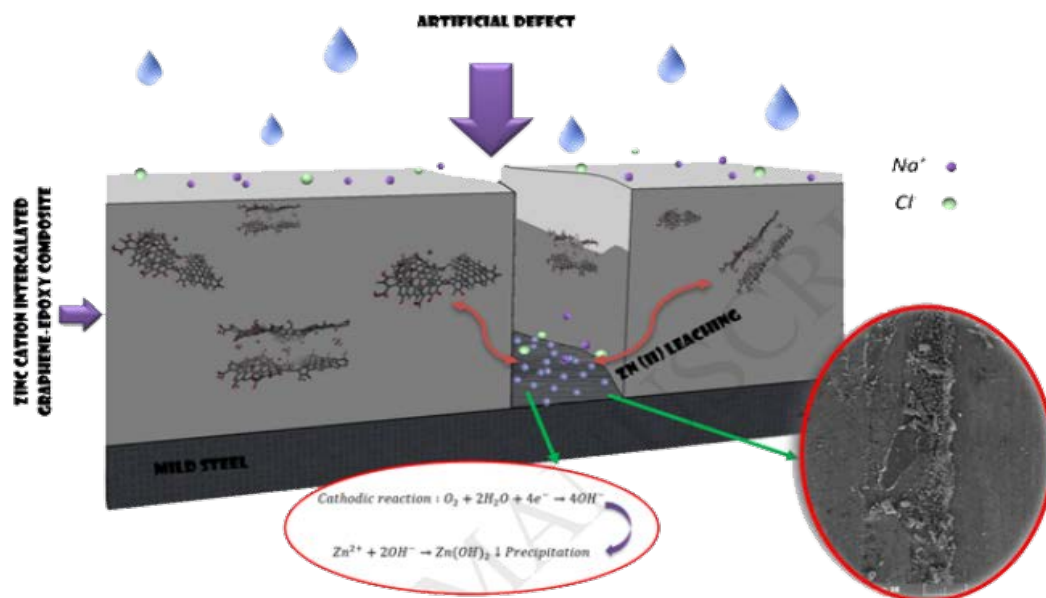
Bahram Ramezanzadeh
Associate Professor
ramezanzadeh-bh@icrc.ac.ir



Zahra Ranjbar
Professor
ranjbar@icrc.ac.ir

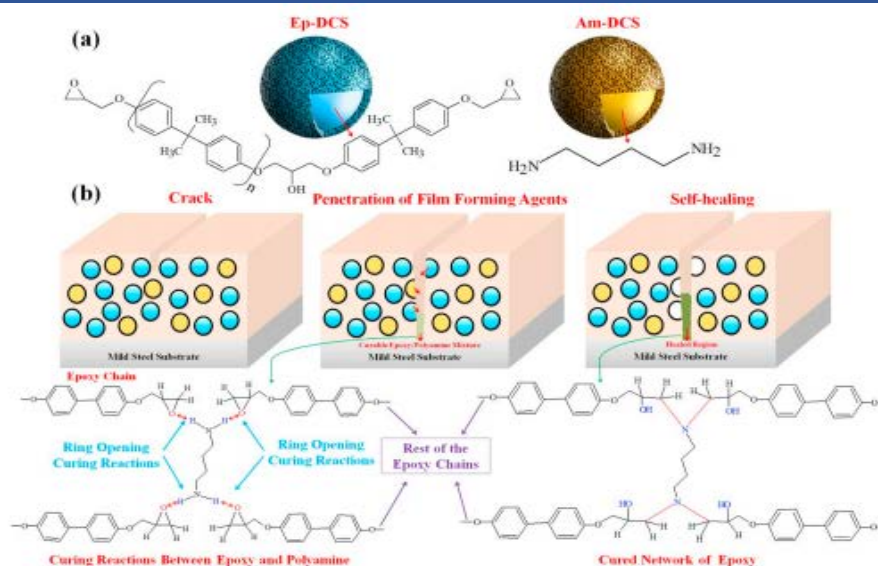


Hossein Yari
Assistant Professor
yari-ho@icrc.ac.ir



Graphene Oxide as a Potential Nanocarrier for Zn (II) to fabricate a Dual-functional Active/passive Protection

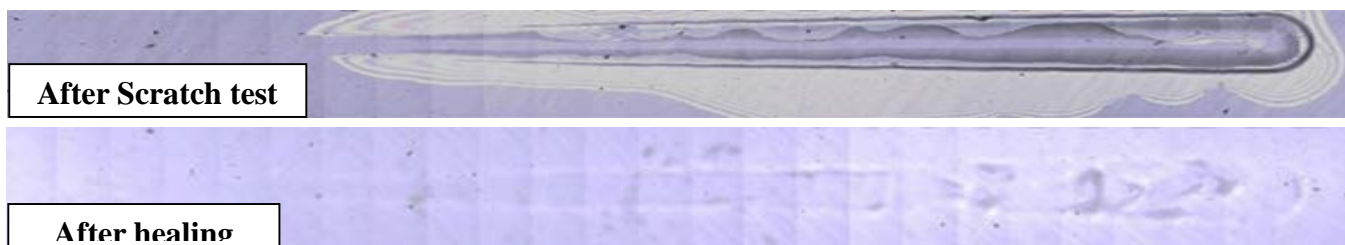
Department of Surface Coatings and Corrosion



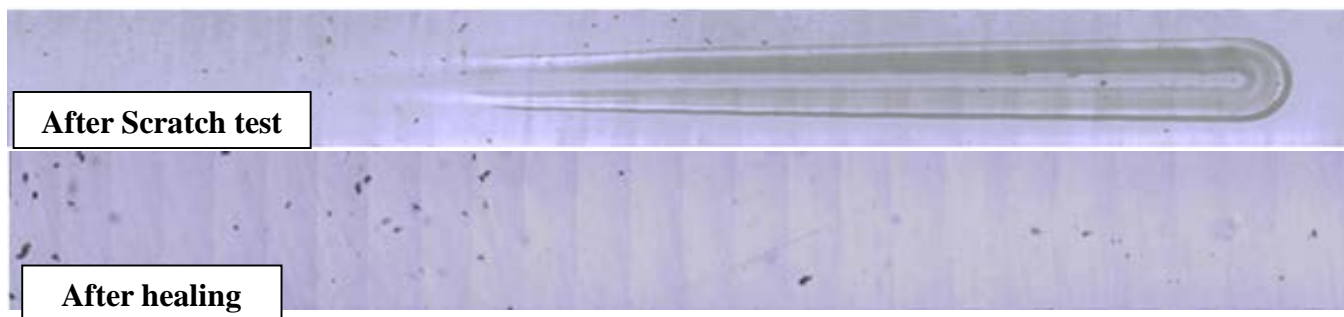
Self-healing epoxy nanocomposite coatings based on dual-encapsulation of nano-carbon hollow spheres with film-forming resin and curing a

Project: Scratch Resistant Automotive Clearcoat with Self-healing capability

Typical Automotive clearcoats – Low scratch resistance and partially healable

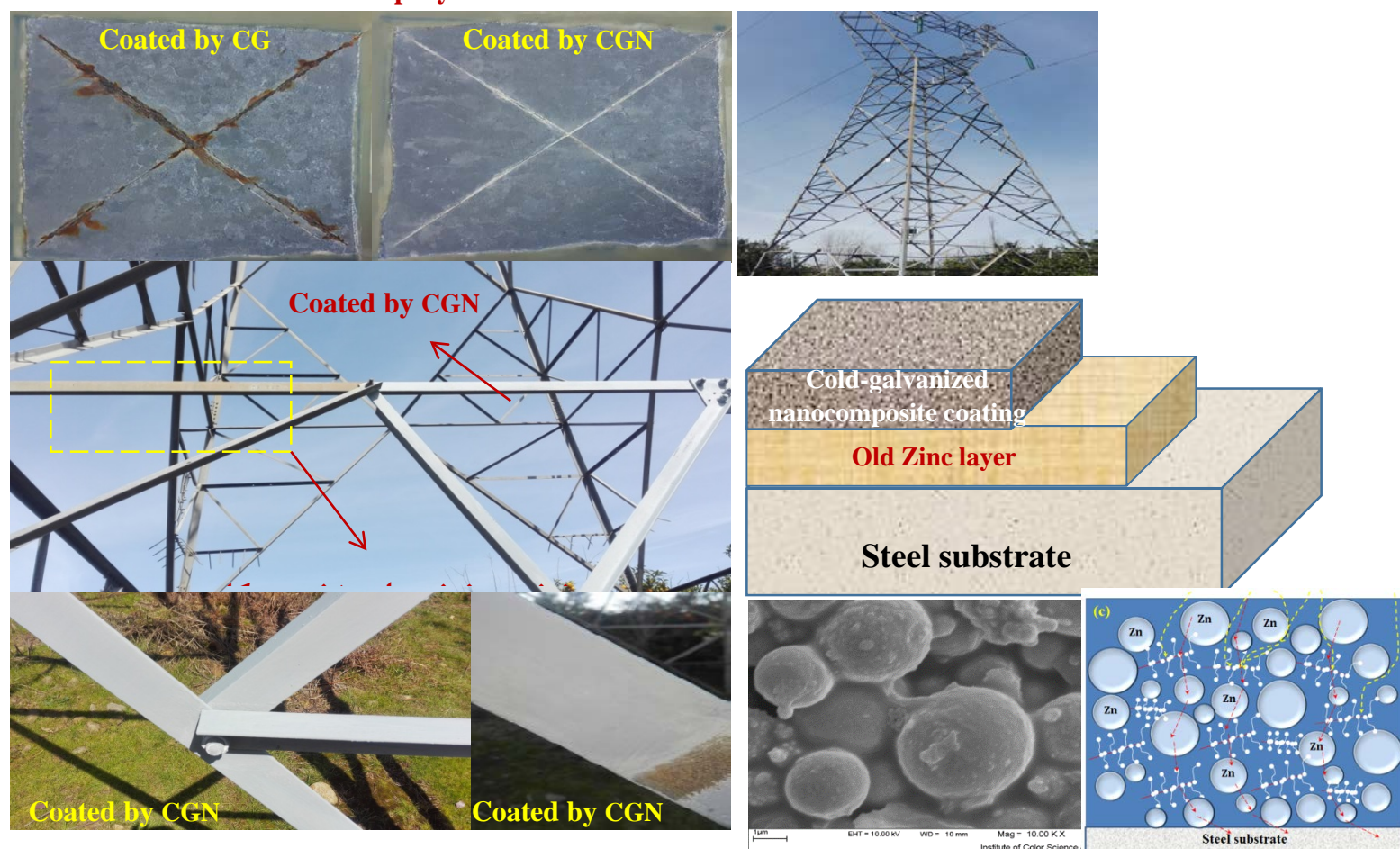


Nanotechnology-based Automotive clearcoat – Highly scratch resistant and Fully healable



Cold galvanized nanocoating (CGN): A single and one-component zinc-rich based nanocomposite coating based on the modified graphene oxide was developed as an effective cold-galvanized coating with long-term cathodic protection properties for application on the power transmission towers.

5000 h salt spray

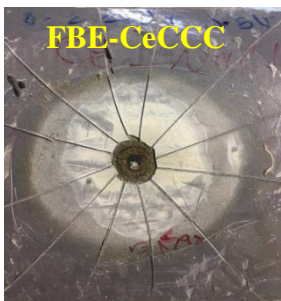
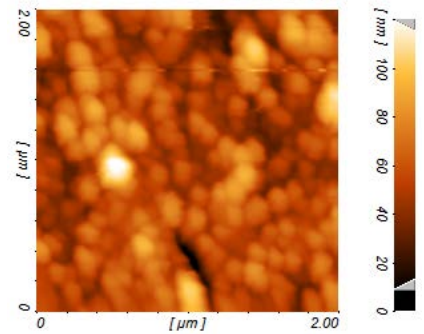
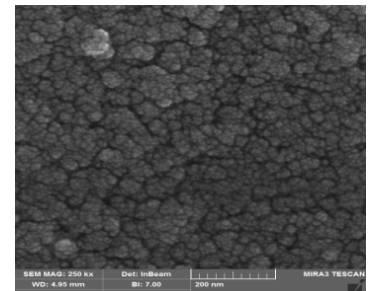
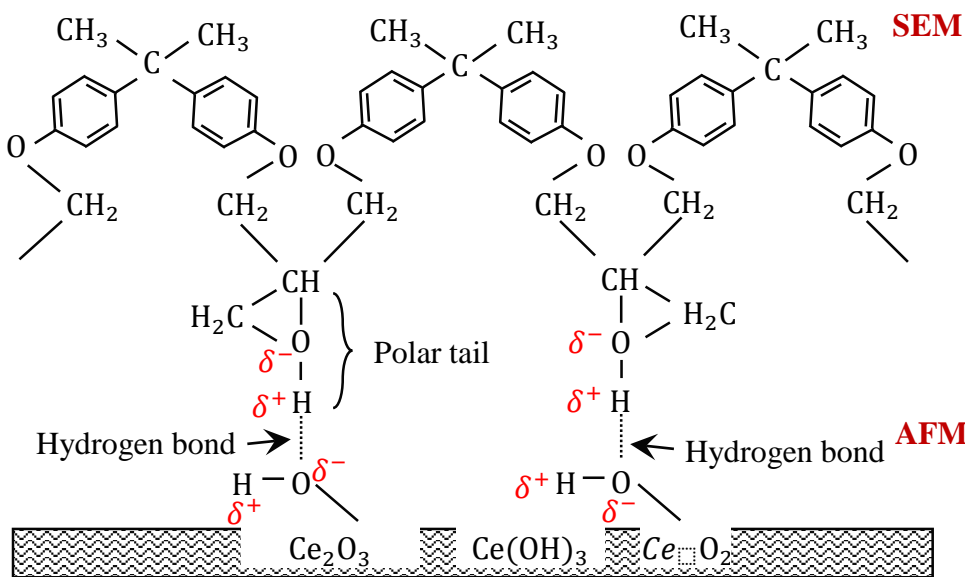


Images of power transmission towers after two years coating with CGN in North of Iran

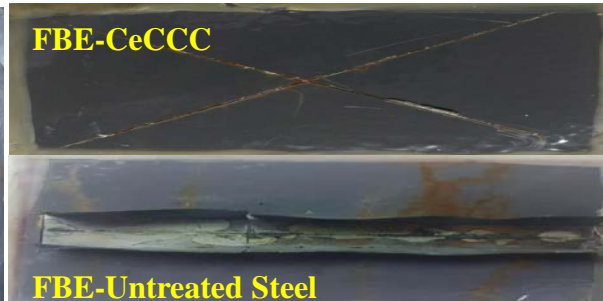
Department of Surface Coatings and Corrosion

Cerium chemical conversion coating (CeCCC)

- **Type of use:** Chemical treatment solution for: Steel structures, storage tanks, pipe line surface (prior paint application)
- **Important specification:** Good adhesion to steel and paint (i.e. FBE, Three-layer PET), high stability in alkaline condition, Low film thickness (<100 nm), good thermal resistance (up to 500 °C), low solubility in water, non-toxic



Cathodic Delamination test



FBE-Untreated Steel

Salt spray test (1000 h)

Department of Resin and Additives



The department provides diverse equipment for bench-scale synthesis of different resins and additives suitable for coating and printing applications. Environmentally-friendly resins and additives can be produced and characterized here. Department also held technical workshops and gives certificate to samples from industry.

Research activities

- Manufacturing and characterization of various industrial and construction resins for high solid, powder coating, UV curable, marine, automotive and traffic paint.
- Synthesis and modification of epoxy, acrylic, urethane, polysulfide, alkyd, saturated and unsaturated polyesters resins used in paint and coating industries
- Synthesis of aliphatic epoxy, silicon and epoxy-silicon resins.
- Manufacturing of epoxy-silicon resin-based coating systems to reduce corrosion costs and increase durability of coatings in the oil, gas and petrochemical industries.
- Manufacturing of coating systems based on silicone resins to reduce back force on vessels.
- Design of modified resins in fireproof coatings, antimicrobials and specialized resins to reduce urban pollutants.
- Synthesis and characterization of additives used in paint and coating industries (dispersants, leveling agent, rheological modifiers, etc.)
- Investigation of kinetics and degradation of resins and polymeric nanocomposites.
- Manufacturing of adhesives and resins used in printing inks
- Manufacturing of modified resins in thermal insulation coatings for buildings and other uses to reduce energy consumption
- Manufacturing of polymer bitumen with special applications for asphalt coatings

Department of Resin and Additives

Facilities

Vacuum oven	A set of reactors for synthesizing	10-liter pilot reactor
Ultrasonic bath	Ultrasonic homogenizer	Brookfield viscometer
Homogenizer	Peristaltic pump	Rotary evaporation
Centrifuge	Conductivity meter	pH meter

Customer services

Consulting services:

Synthesize and characterization of resins and additives.

Behavior and properties of resins in surface coatings (water based, solvent based, powder coatings and UV curable resin), printing inks, adhesives, etc.

Behavior and properties of additives.

Cure kinetic of resins and polymeric nanocomposites

Measurements:

Determination of acid number, hydroxyl number, epoxy number, amine number, soap number, percentage of NCO, Brookfield viscosity, thermal resistance of coating, conductivity measurement, solid percentage, water absorption test, Centrifuge, Vacuum distillation and contact angle.

Distinguished research projects

- Modification and Characterization of Polysulfide Resins by Epoxy Resin
- Synthesis of the Water-based Acrylic Resins \ Nano Silica
- Polyurethane Dispersion (PUD): Synthesis and Characterization
- Synthesis and Characterization of Epoxidized Polysulfide Resin
- Synthesis and Characterization of Radiation Curable Polysulfide Resin
- Preparation of Waterborne Resins Containing Nano Silver Particles and Investigation its Anti-Bacterial Properties
- The Effect of Reaction Condition of Pickering Emulsion Polymerization on The Preparation of Core- Shell Nano-composites
- Synthesis and Study on the Behavior of Rheology Modifiers based on Urethane
- Study of Isotherm and Kinetics of Dye Adsorption onto Zinc Oxide Nanoparticles
- Thermo-analytical Study of the Cure Characteristics of Epoxy – Siloxane
- Synthesis and Characterization of Polydimethylsiloxane-Co-Polyether as Paint Additives (Antifoaming Agents and Leveling Agents)
- Investigation of Effects of Polysulfide Polymer for Bitumen Binder
- Preparation of Conductive Inks for Ink-Jet Printing
- Study on the Stability of Air Dried Long Oil Alkyd Resin in an Aqueous Emulsion Medium
- The Effect of the Solvent on the Morphology of Epoxy Silica Nano-composites Material
- Preparation of Epoxy Amine Adduct for Electro-deposition Application
- Preparation of Water - Based Alky / Acrylic Hybrid Resins

Department of Resin and Additives

- Encapsulation of Thermo-chromic Dyes with Acrylic Polymers
- Study of the Effect of Nano Silica Particle on the Curing Reaction and EIS Behavior of Epoxy Coatings
- Synthesis of Biocompatible and Antibacterial Titanium Dioxide Nanopowders and their Use in Preparation of Hybrid Nano-composites via Ultrasonic Irradiation
- Optimizing The Time and Heating Rate in E.A. Laser Jet Toner Synthesis on Account of Experimental Design Approach
- Feasibility Study of Accessing Know - How for Production of Nucleating Agent and Clarifiers of Polymers based on Sorbitol
- Feasibility Study of Production of Voltatex E1151 Varnish
- Preparation of Technical Tendered Documents of Paints for Double-Deck Wagon of Metro
- Feasibility Study of UV Curable Resins in The Repair and Reconstruction of Copper Inscriptions
- Novel Resins Preparation for incorporation into Protective Coatings for Galvanized Steel Structures
- Preparation of PVC Powder Composition to be Used in Slush Molding Process
- Investigation on Hybridization in Zinc Rich Protective Coatings
- Study on Synthesis and Properties of Siliconized Epoxy Resin
- Surviving of Laboratory Performance Tests and Certification of 6 Types of Pars Pamchal Protective Coating System
- Design and Synthesis of Two Types of Acrylic Polycarboxylic Dispersants
- Synthesis of Polycarboxylate Ether (PCE) Superplasticizer for Concrete
- Reducing Asphalt Emissions Rate via Modification of Bitumen using Recycled Polymers and Natural Bitumen
- Synthesis of Suitable Resin for Coatings Containing ZnS Nanoparticles with Luminescence Feature.

Department of Resin and Additives

- Calculation of The Diffusion Function Naphthalimide Based Disperse Dyes on Polyethylene Terephthalate Fiber
- Synthesis of the Nano composite of Ferrite Ni-Zn and Investigation of its Rheological Properties
- Synthesis and Study of Novel Resin Based on Epoxy-Silica Ceramers for Protective Coatings
- Study on the Effect of the Material Parameters on the Production of Siliconized Epoxy Resin
- Preparation and Investigation of Optical Properties of Nano Multilayer Polymer Films
- Synthesis and Characterization of Suspension of Polymer Nano- Particles
- Curing Kinetics of Epoxy Clay Nanocomposites
- Investigation of Surface Properties of Silicone Based Resins Used in Foul Release Coatings in the Presence of Carbon Nano-Tubes.
- Removal of Dyes Used in Printing Industry from Wastewater by Functionalized Silica Nanoparticles
- Synthesis of Laser Jet Toner via in Situ Suspension Polymerization Method Based on Styrene Monomer
- Preparation and Properties of Hybrid Nanocomposites of Carbon Nanotubes and Epoxy Polysulfide Resin
- Preparation of Carbon Nanotubes by using of Nanoporous Materials
- Synthesis of Polymeric Micro/ Nano Capsules Used in Self- Healing Coatings
- Synthesis and Characterization of Hyper- Branch UV- Curable Acrylate Resin
- Rheological Behavior of Epoxy - Clay Nanocomposites
- Improvement of Thermo Mechanical Properties of Waterborne Resins using Nano Silica
- Optimization of Formulation and Properties of Waterborne Alkyd/ Acrylic
- Synthesis of Nanocomposite based on Acrylic / Nanosilver Particles
- Synthesis of Self Colored Acrylic Based Polymers with Naphthalimide Graftings

Department of Resin and Additives

- Investigation of the Effect of Silica Nano Domian on Viscoelastic Behavior of Silicone-Based Foul Release Coating
- Study on Optical and Morphological Behaviors of Radiation Curable Acrylate- Poly (Dimethyl Siloxane) Blends
- Synthesis and Cathodic Electrodeposition Behavior of Polyether Organic-Inorganic Compounds
- Study on Inorganic Precursors Effect on Surface and Optical Properties of UV- Curable Nano- Hybrid Coatings
- Investigation on Antibacterial Properties of Solid Epoxy and Polyester Resins for Powder Coatings in the Presence of Nano Particles.
- Synthesis and Characterization of UV-Curable Trimethoxysilyl-Functional Urethane Acrylate Used in Hybrid Coating
- Synthesis and Characterization of Silicon Methacrylate as Additive for UV Curable Coatings
- Nano Hybrid of Cationic Polyurethane Dispersion with Nano SiO₂/TiO₂: Synthesis and Characterization
- Investigation on Effect of Nano Clay on Rheological Behavior of Epoxy Polysulfide Resin
- Synthesis and Characterization of UV-Curable Nano-Silica Novolac Epoxy Acrylate
- Poly (Methyl Methacrylate) SiO₂ Nano-composites Prepared by Power Ultrasonic Wave: Synthesis and Characterization
- Synthesis and Characterization of UV-Curable Poly dimethylsiloxane Urethane Di methacrylate / CNT
- Synthesis and Characterization of UV Curable Nanocomposite Tri Functional Urethane Methacrylate SiO₂
- Synthesis and Characterization of UV Curable SiO₂/ TiO₂ Nano-hybrid as a Photocatalytic Coatings
- Synthesis and Characterization of UV-Curable Epoxy Acrylate/ Fe₃O₄ Nano Hybrid

Department of Resin and Additives

Members



Ali Jannesari

Associate Professor

jannesari-a@icrc.ac.ir



Farhood Najafi

Associate Professor

fnajafi@icrc.ac.ir



Malihe Pishvaei

Assistant Professor

pishvaei@icrc.ac.ir



Mohammadreza Saeb

Assistant Professor

saeb-mr@icrc.ac.ir



Behzad Shirkavand

Associate Professor

shirkavand@icrc.ac.ir

Department of Nano Materials and Nano Coatings



The Department of Nano Materials and Nano Coatings was established in 2009 on the basis of the Scientific and Educational Innovation Center. At the present time, the department has formed a qualified scientific staff of professional specialists in the field of nanomaterials.

Research activities

- ❖ Preparing and applying of different functional nanomaterials
- ❖ Development of various formulations of nanocoatings
- ❖ Proposing and of conducting of industrial projects and scientific researches in the field of nanocoatings, thin films and nanomaterials

Facilities

Magnetron Sputtering Device	Laser particle size analyzer	High-speed Centrifuge
Spin Coater	Field-emission Tester	Sonicator UP200s
Electrophoresis Coater	Atmosphere controlled high temperature furnaces	Langmuir-Blodgett Device

Customer services

- Synthesis of different nanomaterials
- Functionalizing of nanomaterials
- Characterization of all nanomaterials

Distinguished research projects

Development CrCN hard coating technology

Development of new nanocatalysts

Preparation of thermochromic coatings based on nanotechnology

Feasibility of making ceramic coatings on the surface of pump blades

Synthesis of new metal-organic framework (MOF) nanocomposites

Members



Morteza Ganjaee

Assistant Professor

ganjaee-mo@icrc.ac.ir



Mehdi Ghahari

Associate Professor

maghahari@icrc.ac.ir



Mehrnaz Gharagozlou

Associate Professor

gharagozlou@icrc.ac.ir



Sara Khamseh

Assistant Professor

khamseh-sa@icrc.ac.ir



Sousan Rasouli

Associate Professor

rasouli@icrc.ac.ir



Mehran Rostami

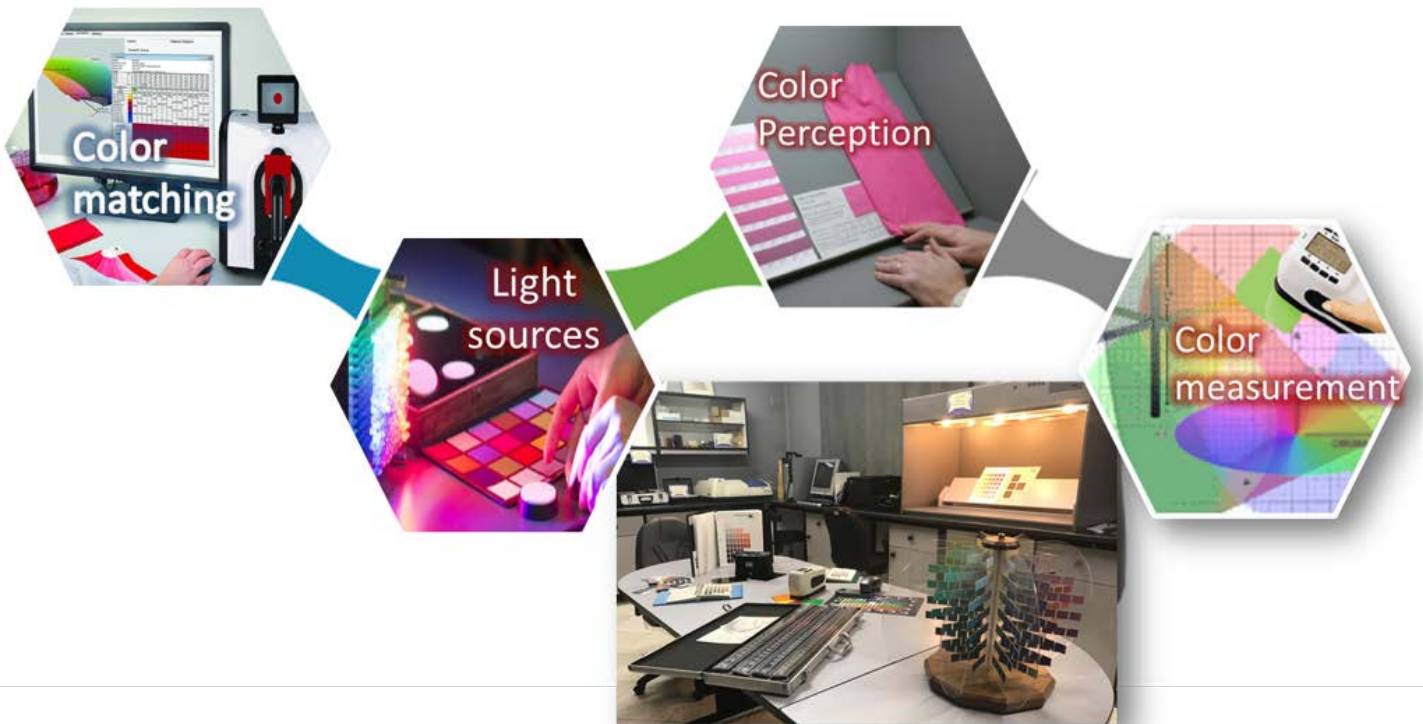
Assistant Professor

rostami-m@icrc.ac.ir

Department of Color Control and Color Reproduction



Color science is a fundamental field of science dedicated to understanding the creation of colored stimuli, sources of illumination, and the human perception of color. Color physics is used in the design and production of most man-made materials and to specify the properties of diverse natural materials such as skin, plants, animals, and soil. The focus of the department of color control and color reproduction is researches on object's color appearance, color matching and recipe prediction, color difference modeling, illumination sources, psychophysical effect of color based on visual assessment experiments, color measurement and color quality control in the wide variety of areas including of paint, plastic, textile, automotive, dentistry, lighting, cosmetic, ceramic, packaging, and food.



Research activities

This department has developed activities in the following areas :

- ✦ Description of object's color appearance including of spectral behaviors, colorimetric coordinates, gloss, opacity, translucency and whiteness, yellowness, blackness indices.
- ✦ Characterization of different color appearance models .
- ✦ Color matching and recipe prediction.
- ✦ Color difference modeling .
- ✦ Characterization of visual phenomenon such as metamerism, chromatic adaptation and color constancy.
- ✦ Light sources and their effect on color and appearance .
- ✦ Investigation of psychophysical color phenomena based on visual assessment experiments.
- ✦ Using intelligent systems for evaluating color appearance and color reproduction.
- ✦ Applications of color measurement and color quality control in wide variety of areas including of paint, plastic, textile, automotive, wood, paper, lighting, cosmetic ceramic, packaging, dentistry and food.
- ✦ Spectral and colorimetric analysis of achromatic samples.

Customer services

Customer services include:

- ❖ Measurement services as a collaboration laboratory of Iranian national standard organization, having an accreditation certificate from NACI in the field of color measurement, color difference, color stability, color strength, gloss, haze, opacity, transparency and spectral behavior analysis in the UV-VIS-NIR regions of the spectrum.
- ❖ Calibration of reflectance spectrophotometer devices with having a calibration laboratory accreditation certificate from Iranian national standard organization.
- ❖ Color matching and recipe prediction in different industries such as textile, plastic and paint industries.

Department of Color Control and Color Reproduction

- ❖ Presenting appropriate color difference formula for determination of color difference tolerance limits in different industries.
- ❖ Investigation of process parameters effect on color appearance of product.
- ❖ Presenting a model to estimate the surface appearance in automotive finishes.
- ❖ Investigation of optical behavior of Nano structure materials.
- ❖ Applying of nondestructive methods in analysis of colorants.
- ❖ Spectral reflectance simulation of translucent materials such as tooth.
- ❖ Preparation and developing standards in color measurement and color control fields for different industries.
- ❖ Consulting services for laboratory equipment in the areas of color measurement and color quality control.
- ❖ Colorimetric analysis of samples based on visual assessment experiments.
- ❖ Design and manufacture of color assessment cabinets.
- ❖ Testing for type and degree of color vision deficiency, having a NACI laboratory accreditation certificate.

Facilities

Gretag-Macbeth Color-Eye 7000A Spectrophotometer to measure spectral reflectance and transmittance in the 360-750 nm range.
Xrite SP-64 Spectrophotometer to measure spectral reflectance with hemispherical geometry ($d/8^\circ$) in the 400-700 nm range.
Gretag-Macbeth Color-Eye 741GL Gonio Spectrophotometer to measure spectral reflectance at 20, 45, 75 & 110 aspecular angles in the 360-750 nm range.
Gretag-Macbeth Light Spex Spectroradiometer to measure spectral power distribution of light sources in the 360-750 nm range.
Novo Gloss I.Q. Goniophotometer to measure gloss, haze, distinctness of image values at 20 and 60 degrees.
Analytik Jena Specord 250 UV-Visible-NIR Spectrophotometer to measure spectral reflectance and transmittance in 190-1100 nm range.
Avian Technologies BCRA standard ceramic set (BCRA-14-02c8H set).
Ihara Spectrocam Spectrophotometer to measure reflectance with $0/45^\circ$ geometry in the 400-700 nm range.
Munsell Books of Color (Glossy & Matt).

Fransworth Munsell 100 Hue Color Vision Test.
Starna Certified Reference Neutral Density Glass Filter set to assess photometric accuracy of transmittance spectrophotometer in the visible region.
Starna Certified Reference Holmium Glass Filter to assess wavelength accuracy in the UV –Visible regions.

Distinguished Projects

1. Optimization of computer color match prediction procedures with the aid of spectral decomposition theory.
2. Reconstructing metameric black from the color coordinates by using neural network and spectral decomposition theory.
3. Reconstruction of reflectance curves based on tristimulus values using interpolation Algorithm.
4. Evaluation of geometric attributes of automotive coatings.
5. Investigation of the correlation between instrumental measurements and visual assessments of the gloss.
6. Investigation of the effect of distinctness of image and its measurement methods on the appearance of automotive finishes.
7. Design and manufacture of two cabinets for visual assessment of surface appearance.
8. Light matching of standard illuminants by LEDs light sources.
9. Evaluation of unlevelness of dyed textiles with spectrophotometer and scanner.
10. New method for a data set for fuzzy color naming and application in color space.
11. Strategic study of the production of a display.
12. Study of optical and physical properties of carbon nanotubes coatings.
13. Designing a colorimeter to reconstruct reflectance curve of an object.
14. Instrument dependency of kubelka-munk theory in computer color matching.
15. Comparative study of neural networks with physical models in computer color matching.
16. Color matching for digital printing.
17. Effect of bleaching process on color change of tooth samples.

Department of Color Control and Color Reproduction

18. The effect of aging on discoloration of amaris, a highly esthetic composite.
19. The Effect of different polishing procedures on discoloration of grandio and point4 composite resins.
20. Assessment of the color inconstancy index of natural colorants.
21. Effect of CIELCH coordinates on selection of preferred black.

Members



Farhad Ameri
Associate Professor
fameri@icrc.ac.ir



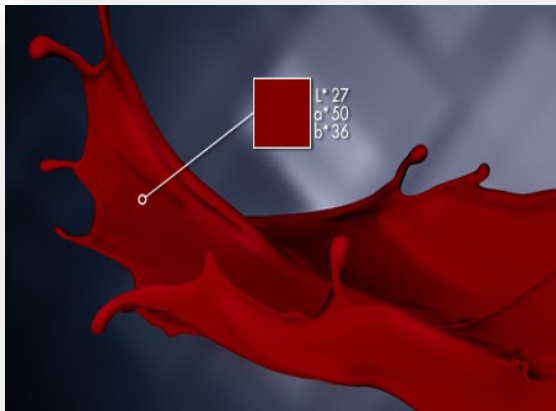
Razieh Jafari
Assistant Professor
jafari-ra@icrc.ac.ir



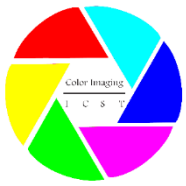
Mahdi Safi
Assistant Professor
mahdisafi@icrc.ac.ir



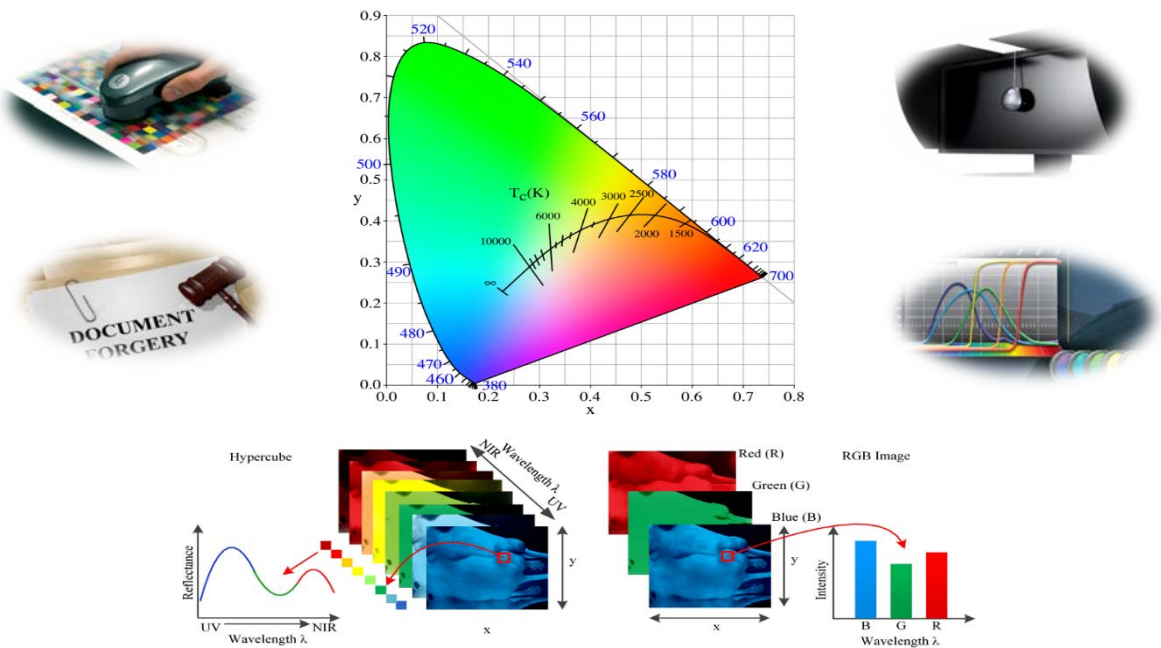
Design of two illumination/observation set up, Directional & Diffuse for color appearance assessment



Color matching and recipe prediction



Ever-increasing growing rate of color reproduction devices such as monitors, printers, cameras and scanners have caused new developments in color physics applications. Acquiring images with desirable qualities and the possibility of transmission of images with color appearance fidelity has introduced subjects such as color gamut, gamut mappings, color management and so on. CICIP department is targeting the mentioned aims in both scientific and practical approaches.



Research activities

This department has focused on activities in the following areas :

- ✦ Color management in digital printing
- ✦ Multispectral (Hyper-spectral) Imaging
- ✦ Near-infrared image processing
- ✦ Identity document forgery
- ✦ Colorimetry
- ✦ Light sources and illuminating
- ✦ Color design and harmony
- ✦ Color matching and color formulation
- ✦ Calibration, design and producing color measurement instruments
- ✦ Design and manufacturing of color filters
- ✦ Polychromatic tunable light sources
- ✦ Estimation of intrinsic image, shading factor and specular gloss from any images of objects

Customer services

Customer services include:

- ❖ Spectral (VIS and NIR) and colorimetric analysis of materials (Solid Colors and Special Effect Pigments)
- ❖ Colorimetric calibration and characterization of color devices (Monitors, Printers, Scanners, Projectors)
- ❖ Running and implementing psychophysical experiments
- ❖ Personnel's training
- ❖ Preparation of related standards
- ❖ Estimation of color gamut (reachable colors) of different kinds of color reproduction devices.
- ❖ Lightening and color design for indoor and outdoor environments
- ❖ Light source and illuminant characterization

Department of Color Imaging and Color Image Processing

- ❖ Photometry and radiometry
- ❖ Color control lab design
- ❖ Measurement of color change in dental materials
- ❖ Color measurement and color image analysis for quality control of agricultural and food products

Facilities

EYE-One spectrophotometer with spectral reflectance and color coordinates measurement capability and spectral irradiance and luminance measurement (45/0 sampling geometry)
Monochrom CCD Thorlabs CCD- DCU224M
Thorlabs interference and neutral filters in visible and NIR region
Professional digital cameras and lighting instruments
Profiling package for printers, monitors, scanners,...
Digital microscopes with 200x and 500x magnification power with the ability of picture taking and film recording
Digital Color Checker SG (X-rite) chart, Spirit paint 1750 catalogue, standard SDC gray samples , RAL K5 classic and RAL D4 Design samples, metallic pantone chips,...
Konica Minolta CS2000 spectroradiometer (380-780 nm)
EIZO CG243W Wide Gamut Display
TES-133 Luminous Flux Meter to measure spectral power distribution of light sources
Standard light cabinet with D65,F11,A,UV,C light sources
Ocean Optics NIR Quest 256 probe spectrometer (900nm-2500nm)
Hunterlab Minisacn 45/0 spectrophotometer with 0.5" and 1" apertures

Distinguished projects

Some current research projects

1. Design and manufacturing of color filters for multispectral imaging
2. Design and manufacturing tunable light sources using color primaries
3. Design and manufacturing transmission spectrophotometer using 2D CCDs
4. Color change of dental materials due to color affecting factors
5. Applying color measurement and color image analysis for quality control of agricultural and food products
6. Estimation of intrinsic image, shading factor and specular gloss from any images of objects

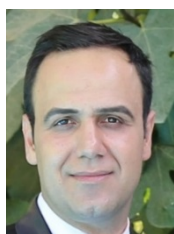
Some completed research projects

1. Optimum Band Selection for Multispectral One-shot sensor for Face Recognition in Visible and Near-Infrared spectrum
2. Determining the sequence of print and ink in document forgery
3. Evaluating the performance of staffs and its relationship with the light source parameters used in the work room
4. Application of a color scanner as a colorimeter
5. Evaluating stone chip (chipping) resistant test using scanner
6. Evaluating adhesion resistant test (Cross Cut) using scanner
7. Color transferring of an art image into urban elements using principle component analysis

Members



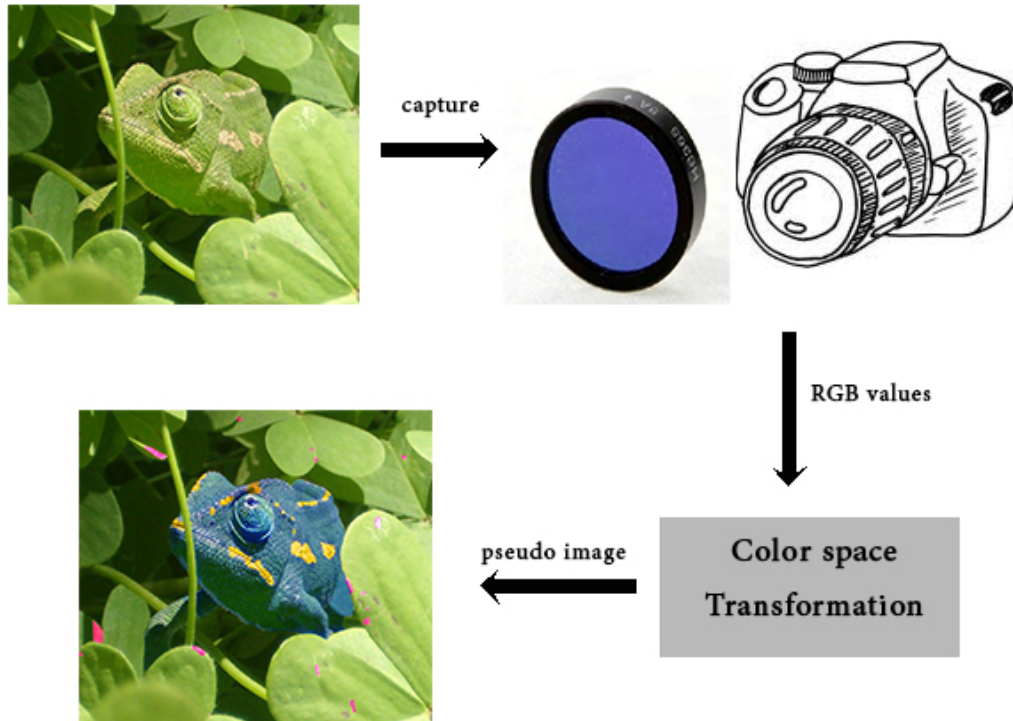
Keivan Ansari
Assistant Professor
kansari@icrc.ac.ir



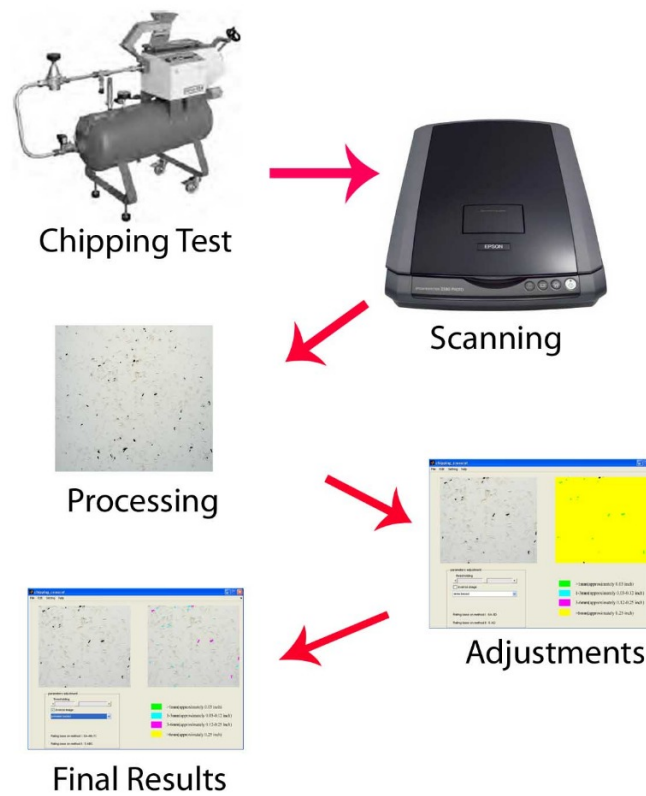
Ali Reza Mahmoodi
Assistant Professor
amahmoodi@icrc.ac.ir



Mahdi Safi
Assistant Professor
mahdisafi@icrc.ac.ir



Detectability enhancement using optical filters and image transformation



Evaluating stone chip (chipping) and adhesion resistant test (Cross Cut) using scanner



Design and manufacturing transmission spectrophotometer using 2D CCDs



Printing industry is one of the most important industries in developed and growing countries, possessing high value added. In aforementioned countries, the printing industry relies on scientific research, in a way that printing projects cost millions of dollars annually. In line with these considerations, printing technology department of ICST as the pioneer research center in Iran and Middle East, taking advantage of expert staff and laboratory facilities, is ready to offer services to industries and scientific centers.

Research activities

- Formulation of various types of printing inks, digital inks and toners
- Investigation of physical properties and surface phenomena (rheology, surface energy, surface tension, pigments dispersion, ink transfer, ...)
- Formulation of different types of functional inks applied in different industries such as electronic, food, medical, energy and smart documents
- Physico-chemical methods for surface treatment of different materials in order to obtain better printability
- Reverse engineering, analysis and quality control of printing products
- Training expert staff and students at post-graduation degree
- Holding of educational seminars and workshops

Laboratory Services and Testing

Quality control of ink:

- Ink adhesion to substrate
- Electrical conductivity of electronic inks
- Print ability of inks
- color and density measurement of inks and printed materials

Department of Printing Science and Technology

- Rub resistance of printed materials
- Surface tension and energy of inks and substrates
- Lab equipment for preparation of various inks
- Assessment of print resistance to water, acidic, basic and oily solutions

Facilities

Four Point Probes	Three Roll Mill	Netzsch Minicer	Spectrodensitometer	Automatic Offset Proofer
Spin Coater	3D Printer	Screen Printer	Ink Jet Printer	Gravure/Flexo Proofer
Zahn Cup	Tensiometer	VIEEW digital image analyzer	LaserJet Printer	Ink Rub Tester
Grindometer	Transfer Sublimation	Viscosity Cup	Pycnometer	Bar Coater

Distinguished projects

1. Formulation of digital sublimation inks
2. Formulation of CIJ inks based on dyes and pigments
3. Formulation of single and double component toners from recycled materials
4. Formulation of conductive inks in order to print on paper and textile
5. Designing of flexible laboratory samples of organic emitting diodes
6. Formulation of lacquer for pharmaceutical packaging
7. Preparation of gravure ink to print on wallpaper
8. Study of operational factors affecting toner production
9. Formulation of digital inks for desktop and large format applications
10. Formulation of antibacterial inks
11. Formulation of self-cleaning ink
12. Formulation of UV- curable offset printing ink
13. Preparation of smart photochromic and thermo chromic labels by ink jet printer

Members



Maryam Ataefard
Associate Professor
ataefard-m@icrc.ac.ir



Saeed Bastani
Associate Professor
bastani@icrc.ac.ir



Mojtaba Jalili
Assistant Professor
jalili@icrc.ac.ir

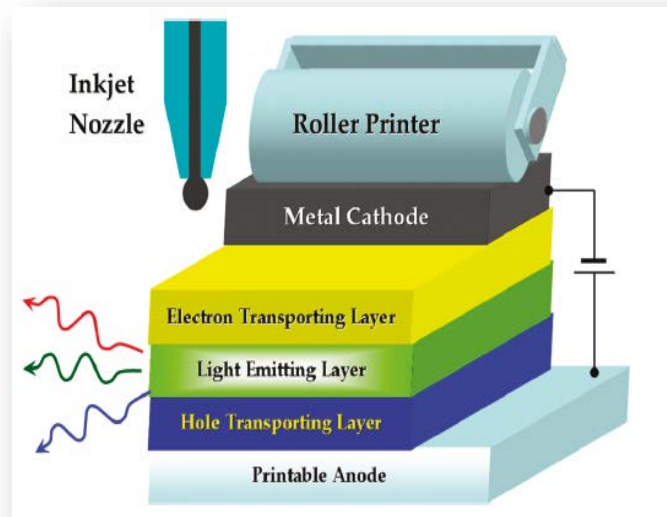


Atasheh Soleimani- Gorgani
Associate Professor
asoleimani@icrc.ac.ir



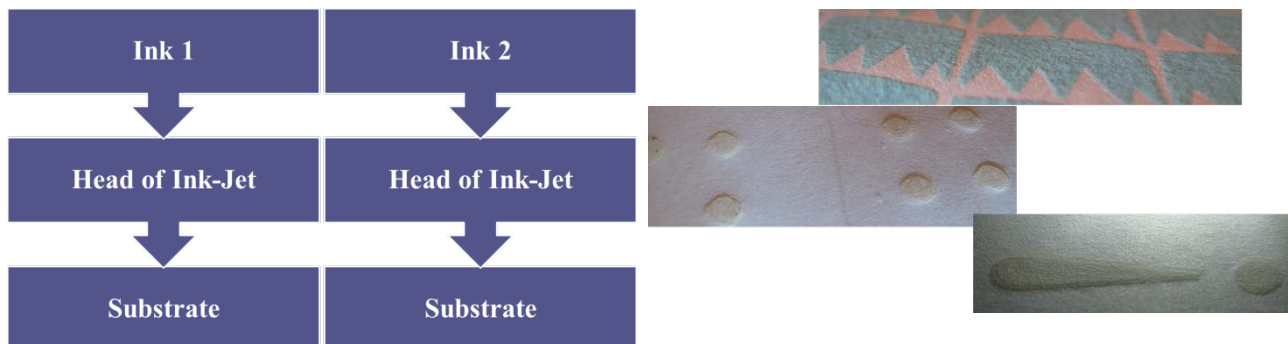
**Mohsen Mohammad
Raei Nayini**
Assistant Professor
mnavini@icrc.ac.ir

Flexible Organic Light Emitting Diodes by ink-jet printing



Nation Project

Three-dimensional ink-jet printing by home and office ink-jet printer



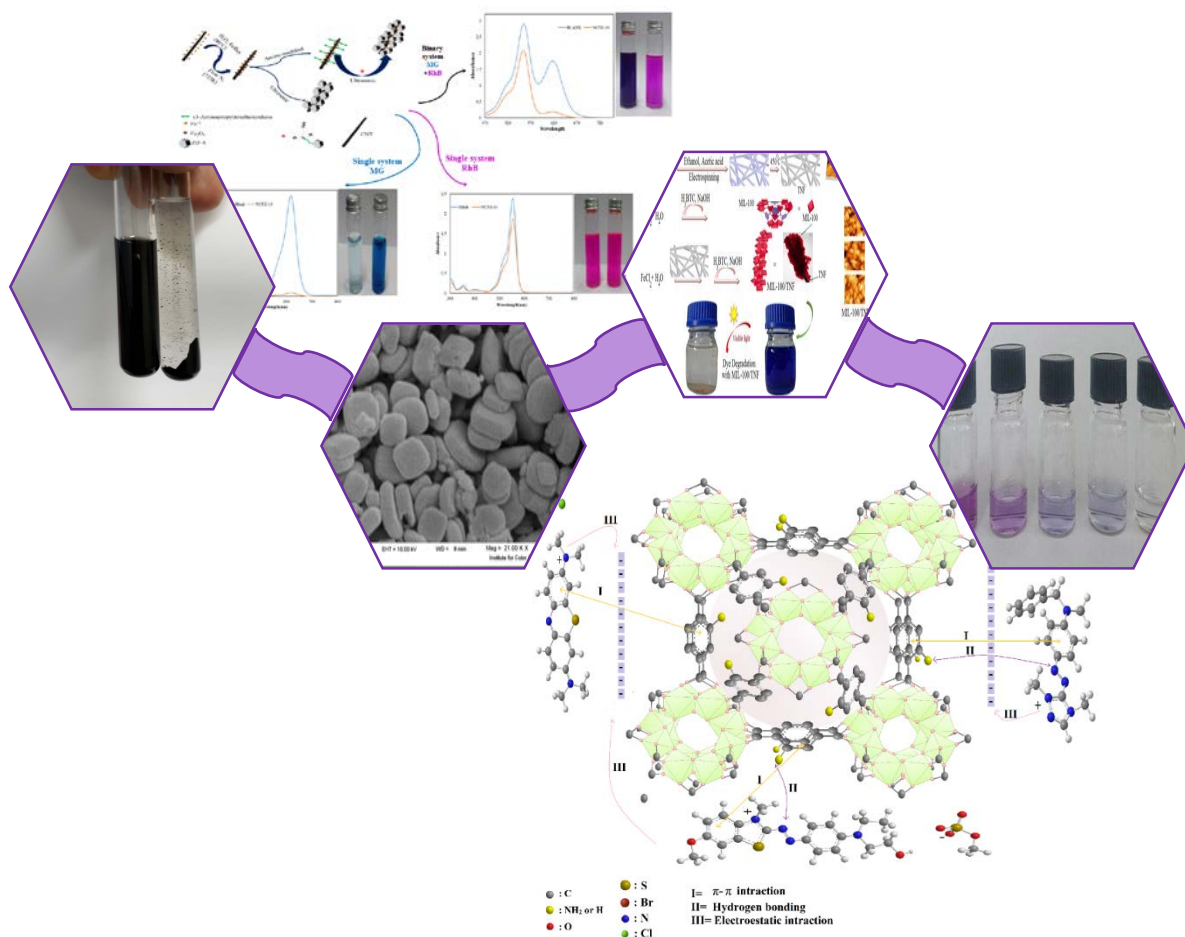
US-Patent

Application No:13/730913

Department of Environmental Research



Control, measurement and monitoring of environmental pollution is one of the most important fields of environmental protection. In this regard, research on waste treatment including Water, Air and Soil is fundamental due to maintaining public health. Furthermore, studies on waste management policies, recycling and development of new environmentally friendly materials and technologies are important. Department of environmental research activities have focused on above mentioned environmental aspects with particular emphasis on environmental problems of dye, paint, resin, glaze and printing industries.



Department of Environmental Research

Research activities

- ❖ Colored wastewater treatment
- ❖ Design and modeling of the industrial waste treatment plants and reactors
- ❖ Researches on the adsorption systems
- ❖ Nano- photocatalytic and advanced oxidation processes
- ❖ Physicochemical processes of waste treatment

Facilities

TOC analyzer (TOC-L CSH, Shimatzu)
COD meter (DR-3900, Hach)
BOD meter and incubator (BOD Track, Hach)
UV-Vis spectrophotometer (Lambda 25, Perkin Elmer)
UV-Vis spectrophotometer (Cecil-CE2021)
Atomic absorption (Flame/Furnace) (PG 990- PG Instruments)
Ion chromatograph (761 Compact IC-Metrohm)
Turbidimeter (2100 N-Hach)
Centrifuge (EBA 20, Hettich)
Electroris (Labscale Electrospinning Unit- Fanavaran nano meghyas)
Conductometer (Mettler Toledo)
pH meter (Mettler Toledo)

Department of Environmental Research

Ultrasonic (Parsonic 15 S)

Distinguished research projects

- Dye removal using physical processes including membranes and adsorption by nanofibers, biomaterials, metal-organic frameworks, etc.
- Application of advanced oxidation technologies (photocatalysis, photo-Fenton, ozonation, etc) to degrade dyes and organic pollutants in wastewater.
- Biological processes for removing pollutants from colored wastewater.
- Detection of pollutants in water using colorants.

Customer services

- Collaboration for measurement of detergent, chloride, free chlorine, color, fluoride, sulphate, Total hardness, calcium, magnesium, nitrate, turbidity, Total Alkalinity (TA), ammonia, Total Suspended Solid (TSS), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD₅), pH, Total Dissolved Solid (TDS), Electrical conductivity (EC) and metal measurements.
- Collaboration in providing environmental standards
- Environmental consulting services
- Design and modeling of the industrial waste treatment plants (Water, Air, and Soil)
- Reducing the environmental impact of dye, pigment, paint, resin, glaze and printing industries by recovery and reuse of resources and the processes optimization
- Fabrication of the adsorption, photocatalytic oxidation, biological, and membrane systems

Members



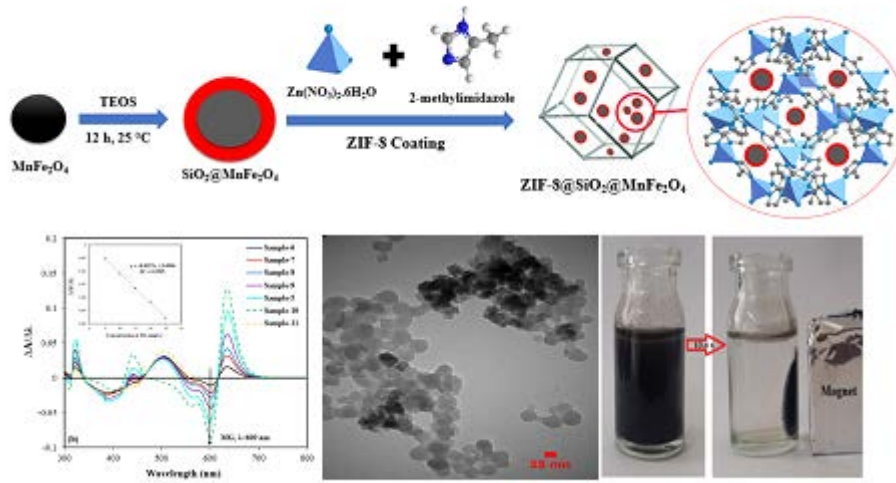
Seyed Masoud Etezad
Assistant Professor
etezad-ma@icrc.ac.ir



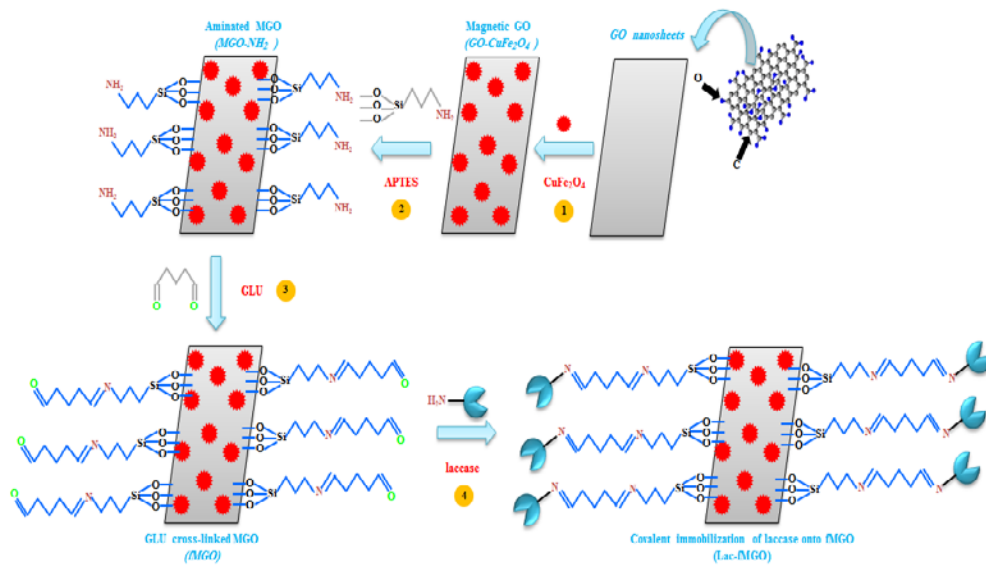
Niyaz Mohammad Mahmoodi
Associate Professor
mahmoodi@icrc.ac.ir

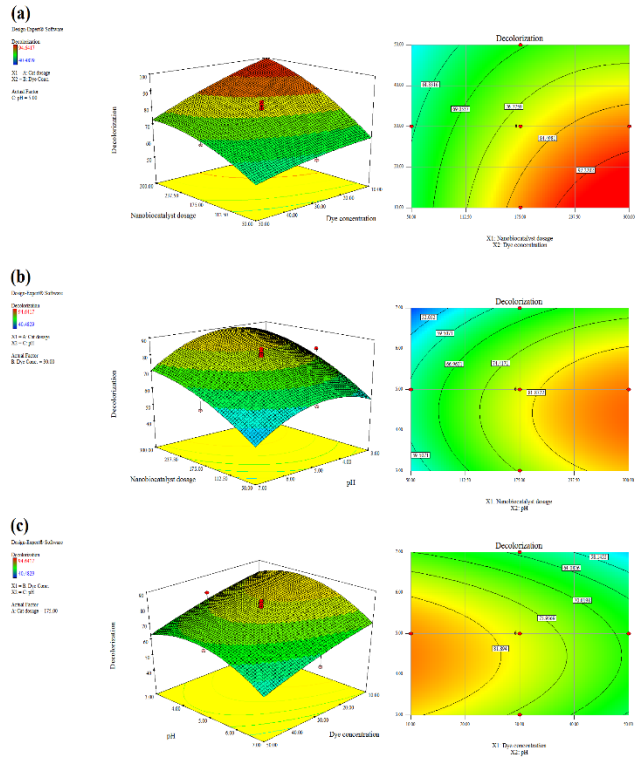
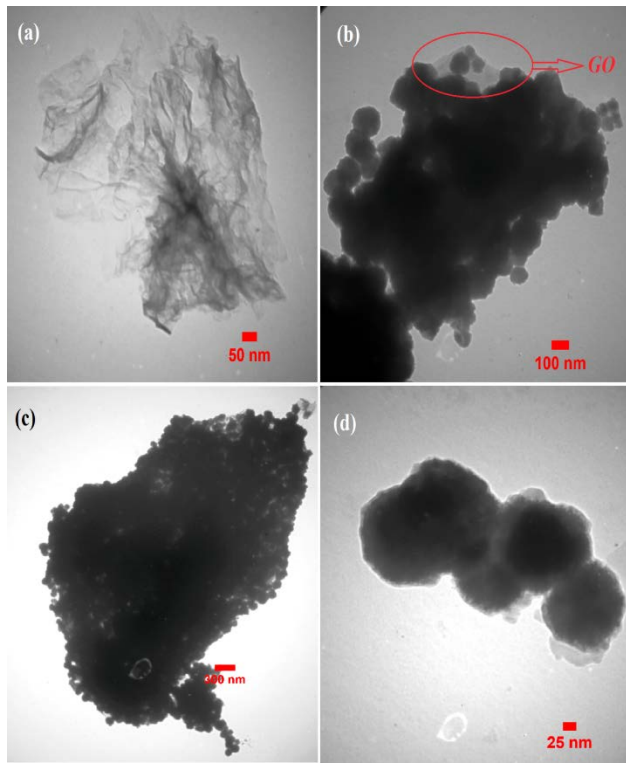


Mohammad Ebrahim Olya
Associate Professor
olya-me@icrc.ac.ir



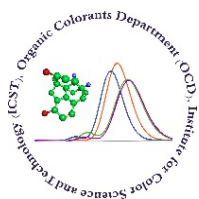
Dye removal using physical processes





Biological processes for removing pollutants from colored wastewater

Department of Organic Colorants



The Department of organic colorants began its research activities as the first of its kind in the country. It is one of the oldest departments of institute for color science and technology and is active in the fields of dyes and pigments chemistry, high tech applications of organic colorants for health, medicine, energy, textile, sensor, cosmetics, and so on at M.Sc. and PhD levels. The department is containing 3 well equipped workshops and laboratories. At present the department has a researcher staff of 4 and M.Sc. students in the various fields of organic colorants, and candidates at the doctoral level. The broad range of researches currently carried out at this department covers areas concerning the design and control of all aspects of dyes, pigments, and processes. The graduates are also active in the old and exposed to rapid expansion of dyes and pigments industry.

Research activities

1. Synthesis and application of organic colorants (Dyes and Pigments) for Textiles, Printing, Food, Drug, Cosmetics, Paint, Paper, Leather, Sensors, Solar Cells etc. industries.
2. Extraction and stabilization of natural dyes
3. Developments in coloration processes
4. Synthesis of traditional and new especial Inorganic pigments
5. Glazes: Formulation, Rheological properties and characterization
6. Treatment and reusability of colored wastewater by physical, chemical and biological processes
7. Pollution prevention and detection in dye, paint, coating, ink, resin and glaze industries
8. Air and soil pollution removal and waste management in dye, paint, coating, ink, resin and glaze industries

Department of Organic Colorants

Facilities

HPLC	Instruments for measurement of color fastness	TLC coater and accessories
Freeze dryer	Incubator shaker	UV-Vis spectrophotometer
Spray dryer	Electrochemical synthesis	Multi spect PDA spectrophotometer
Laboratory dyeing machine	Antimicrobial tests	Fluorescence spectrophotometer

Distinguished research projects

1. Designing and manufacturing dye-sensitized solar cells based on natural dyes in Iran
2. Feasibility and application of biocompatible photoelectrode
3. Antimicrobial finishing on the wool yarn used in handmade carpets using environmentally friendly method
4. Production of super-hydrophobic/oleophobic handmade carpet using new technologies
5. Feasibility study of food spoilage using colored markers
6. Design and construction of Optical nanosensor for rapid test of illicit compounds
7. Green production of hand-made carpets using new technology
8. Extraction and stabilization of anthocyanin dyes by copigmentation and microencapsulation with biopolymers

Customer services

Department of Organic Colorants

Key testing and evaluation areas include:

Our Laboratory offers a broad range of testing services for all types of dyes used in various industries such as textiles apparel and accessories such as casual clothing, outerwear, swimwear, belts, socks, handbags and gloves.

- Detection of certain AZO colorants in dyestuffs.
- Colorfastness of colorants on textiles.
- The separation, identification, and quantification of each component in a mixture by HPLC.
- The pH measurement of water and aqueous solution.
- Water and wastewater analyses by UV-Vis spectrophotometer.
- Determining of fluorescence intensity in redirect photons, analytical chemistry, fluorescence detectors, analyzing the organic compounds by fluorescence spectrophotometer.
- Freezing the product, lowering pressure, then removing the ice by sublimation by Freeze dryer.
- Producing a dry powder from a liquid or slurry by rapidly drying with a hot gas by Spray dryer.
- Antimicrobial testing laboratory that specializing in the testing of textiles, plastics, industrial fluids, paints, inks, and construction materials.
- Accurate Laboratory Sample Dyeing with Level and Reproducible Results works on Advanced Infrared Heating Technology and Hot Air Oven.

Department of Organic Colorants

Members



Kamaladin Gharanjig
Professor
gharanjig@icrc.ac.ir



Mozghan Hosseinnzhad
Assistant Professor
hosseinnzhad-mo@icrc.ac.ir



Mousa Sadeghi- Kiakhani
Assistant Professor
sadeghi-mo@icrc.ac.ir



Shohre Rouhani
Associate Professor
rouhani@icrc.ac.ir

Department of Inorganic Pigments and Glaze



Inorganic pigments and coatings are important due to their ability to resistance at high temperatures and corrosive chemical environments and color stability in tile and whiteware industries.

Research activities

The main research activities of the department are in the fields of high temperature coatings, glaze of ceramics or metals (enamels), chemical resistant coatings, smart coatings and so on. Synthesis of inorganic pigments, special, multifunctional and traditional, producing of different inorganic coatings, designing of new glaze formulations and their preparation and processing are the research topics of our department.

Facilities

Gas Pycnometer	Planetary mill	Box Furnaces (1200 °C-1500 °C)
Polarizing Microscope	Autoclave	Tube furnaces (1600 °C)

Customer services

- Characterization
- Synthesis
- Consulting

Distinguished research projects

Research Activities:

- Rheological properties of ceramic slips and colloids
- Synthesis and characterization of traditional special Inorganic pigments including photo luminescent, magnetic, antibacterial, self-cleaning, electromagnetic, anticorrosion, structural and inclusion encapsulated pigment.
- Formulation of various glazes, enamels and inorganic coatings such as:
 - Tile and porcelain Glaze
 - High temperature coatings
- Characterization of inorganic pigments, glazes and coatings
- Stabilizing of suspensions and colloid systems.
- Consulting with industry and defining of industrial and scientific research projects related to Inorganic pigments and coatings.

Members



Hassan Ahmadi Moghaddam
Assistant Professor
ahmadi@icrc.ac.ir



Amirmasoud Arabi
Assistant Professor
aarabi@icrc.ac.ir

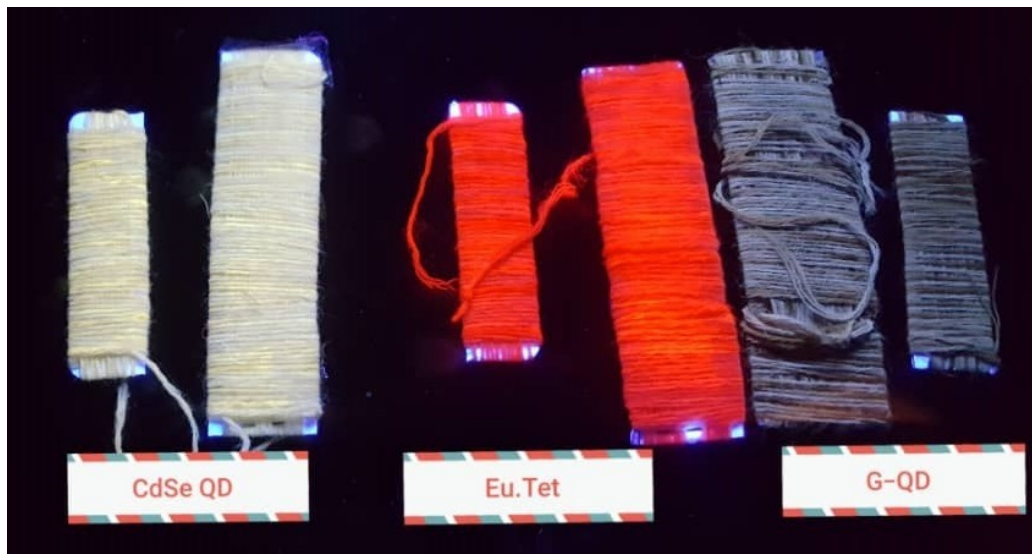
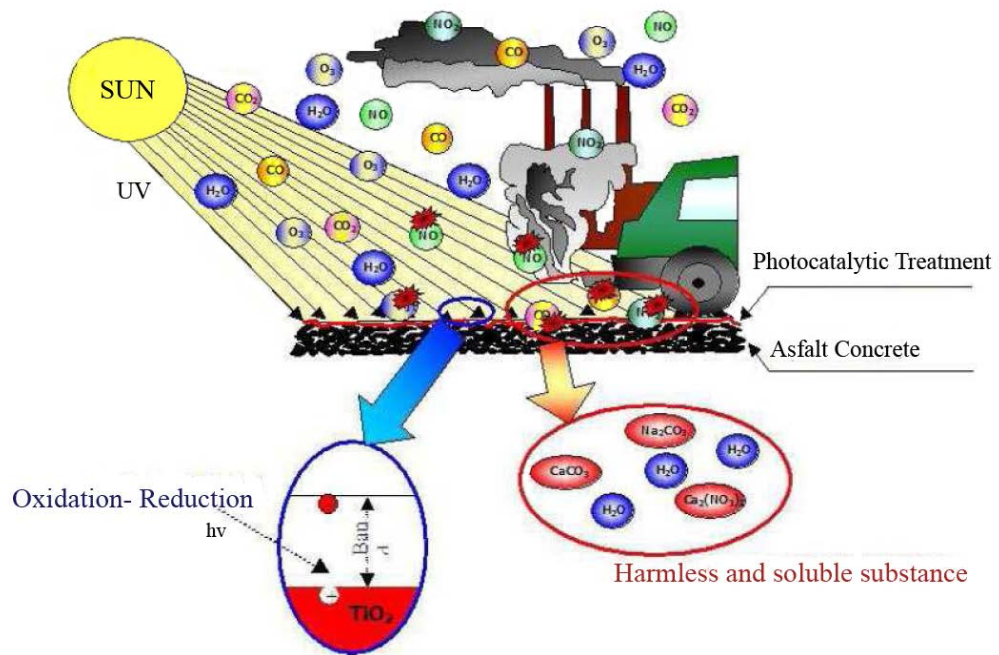


Ebrahim Ghasemi
Associate Professor
eghasemi@icrc.ac.ir



Maryam Hosseini Zori
Assistant Professor
mhosseini@icrc.ac.ir

Department of Inorganic Pigments and Glaze



Color Technology Incubator (CTI)



- This center has been established since 2007
- Working as the center to develop color science and coating

Our clients:

- Small and mediocre entrepreneurs
- Academic staffs
- Graduated students

Main Targets of CTI

- Commercializing new discoveries and innovations in the color science and technology
- Creating new job opportunities
- Supporting the young researchers
- Developing small science-based units
- Developing technology procedures and products

Activities

-Synthesis and development of functional dyes;

E.g. Lasers, liquid crystals, identifiers, sensors, medical dyes, biology dyes or IR absorbant dyes etc.

-Surface coatings and corrosion

Color Technology Incubator (CTI)

-Synthesis and development of industrial dyes;

E.g. decorative, structural, marine, anti-corrosive, radar absorbent and IR camouflage dyes etc.

-Synthesis and development of organic and inorganic dyes;

E.g. alimentary, pharmaceutical, cosmetic, hygienic, textile, paper, leather, ceramic or tile and glass dyes

-Nanotechnology in color industry

-Environmental aspects of color technology

-Image processing

-Color physics

-Printing inks

Services

1-Providing office and laboratory locations

2-General Services

- Organizational Services (computer, print and publication, job processing etc.)
- Foundational Services (electricity, water, air conditioning, phone line etc.)
- Informational Services (permanent guardianship etc.)
- Cleaning Services including office, laboratory and workshop

3-Technological Support

- Using the laboratories located in the Institute for Color Science and Technology (ICST) such as Organic Colorants' Synthesis, Surface Coatings Quality Control, Nanotechnology in color science, Color Physics, Corrosion, Resins and Additives, Printing Inks, The Central Laboratory and the CTI's own laboratorial facilities
- Using the workshops located in the Institute for Color Science and Technology (ICST) including Surface Coatings' Production, Grinding, Inorganic Colorants, The Pilot Unit etc.

Color Technology Incubator (CTI)

4-Consultation services for

- Marketing
- Pecuniary activities
- Managerial skills
- Legal and juridical matters
- Strategic management
- Ideas and Opportunities
- Business plans
- Insurance
- Administration
- Negotiation skills and tactics
- Registering companies
- Technological issues

5-Educational services

Distinguished Projects

1. Manufacturing of high-tech ceramic materials, design and manufacturing and national and international trading of materials and machineries and production line in the field of Ceramic Engineering.
2. Solar energy - Water purifying
3. Nail Polish, Base and Pigment concentrate manufacturer
4. Epoxy, polyurethane, flooring, accelerator, catalyst, polyamine
5. Producing carboxylated polyester and polyester-polyol synthesis formulations for the powder coating and floor coating industries.
6. Synthesis and production of foundry resin
7. Manufacture Anticorrosion coating
8. Construction and Concrete chemicals
9. Color matching software which calculate final recipe to reach the target color

Color Technology Incubator (CTI)



Central Laboratory of the Institute



The client- oriented central lab of ICST possessing highly trained & experienced personnel and numerous facilities, offers a broad range of professional services including (characterization of specimens in compliance with up- to-date and customized standards, data analysis, technical consultation, etc.). It is also capable of providing services related to quality control and certification of submitted qualitative plans in accordance to relevant standards. The policies of the Central Laboratory include providing research and laboratory services to faculty members, researchers and graduate students of the Institute and other universities, and research centers. Standardization of tests and equipment, device calibration and also employing skilled experts in laboratories to ensure accurate results in the shortest possible time is another central laboratory's policy.

Facilities

- ❖ *Raman Confocal Microscopy*
- ❖ *Fourier Transform Infrared Spectroscopy (FTIR)*
- ❖ *Thermo Gravimetric Analysis (TGA)*
- ❖ *Differential Scanning Calorimetry (DSC)*
- ❖ *Dynamic Mechanical Thermal Analyzer (DMTA)*
- ❖ *Thermal Mechanical Analyzer (TMA)*
- ❖ *Particle Size Analyzer (PSA)*
- ❖ *Dynamic Light Scattering (DLS)*

Central Laboratory of the Institute

- ❖ *Scanning Electron Microscopy (SEM)*
- ❖ *Gel Permeation Chromatography (GPC)*
- ❖ *Atomic Force Microscopy (AFM)*
- ❖ *Rheometer (RMS)*
- ❖ *Xenotest*
- ❖ *Dilatometer*

Central Laboratory of the Institute

Members

Head of Central Laboratory

Dr. Seyed Masoud Etezad



Laboratory Experts

Somayeh Pozhhan

Maryam Robotmeily

Shirin Jebeli

Sara Sadeghi

Babak Nazari

Ra'na Rafeai

Central Laboratory of the Institute

Raman Confocal Microscopy



The XploRA PLUS couples a raman spectrometer to a standard optical microscope, allowing high magnification visualization of a sample and Raman analysis with a microscopic laser spot that is widely used for the characterization of materials in terms of their **chemical composition**. This instrument is equipped with two lasers **532 nm** and **785 nm**. XploRA PLUS enables the broadest range of sample analysis such as: Pharmaceuticals, Nano-materials Semiconductors, Polymers, Geology, Chemicals, Art and Museum Forensics.

- Fastest confocal imaging
- Depth Profile for transparent sample
- Non-destructive
- Simple sample preparation
- Water/aqueous phase sampling
- Organic/inorganic molecules
- Amorphous/crystalline

Fourier Transform Infrared Spectroscopy (FTIR)

FTIR Spectroscopy, is an analytical technique used to identify organic, polymeric, and, in some cases, inorganic materials. The FTIR analysis method uses infrared light to scan test samples and observe **chemical properties**. IR Spectroscopy measures the vibrations of atoms, and based on this, it is possible to **determine the functional groups**.

Company: Perkin Elmer

Instrument Model: Spectrum one

Wavenumber Range: **450-4000 cm⁻¹**



Central Laboratory of the Institute

Thermal Gravimeter/Differential Thermal Analyzer (TG/DTA)

The PerkinElmer Diamond Thermo gravimetric/Differential Thermal Analysis (TG/DTA) system combines the flexibility of DTA with the proven capabilities of the TG measurement technology, providing property information for a variety of samples in the temperature range from **ambient to 1500C**. The simultaneous TG/DTA system can be used for such applications as **oxidation, heat resistance, the amount of water, compositional analysis** and the **measurement of ash content** in a sample.



Differential scanning calorimetry (DSC)



Differential scanning calorimetry is a thermo analytical technique in which the difference in the amount of heat required to increase the temperature of a sample and reference is measured as a function of temperature. DSC analysis is used to measure **melting temperature, heat of fusion, latent heat of melting, reaction energy and temperature, glass transition temperature, crystalline phase transition temperature and energy, precipitation energy and temperature, oxidation induction times, and specific heat.**

Instrument Model: Polyma 214

Temperature range: **-150°C - 550°C**

Central Laboratory of the Institute

Dynamic mechanical analysis (DMA)



DMA is the most useful for studying the viscoelastic behavior of polymers. A sinusoidal stress is applied and the strain in the material is measured, allowing one to determine the complex modulus. This approach can be used to locate the **glass transition temperature** of the material, as well as to identify **transitions** corresponding to other molecular motions.

Company: Netzsch

Model: DMA 242C

Temperature Range	-160 - 350 °C
Frequency range	0.01 to 100 Hz
amplitude range	0.1 to 240 μm
Force	8N Static 8N Dynamic

Dilatometer

Dil-101/LT is a precision instrument for the measurement of dimensional changes in material as a function of temperature. Dilatometry can be used to test a wide range of materials including traditional and advanced ceramics, glasses, metals, and polymers. It provides measurements of a wide variety of properties including **linear thermal expansion, coefficient of thermal expansion, sintering temperature, shrinkage steps, and phase transitions.**

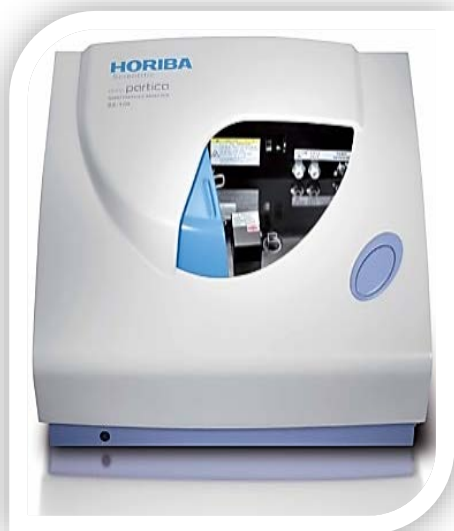
Company: Dama Pazhouh Arvin

Temperature Range	RT - 1100 °C
Resolution	30 nm
Sample length	50mm
Sample Diameter	1 -9 mm
Sample holder	Alumina
Atmosphere	Air



Central Laboratory of the Institute

Dynamic Light Scattering (DLS)



Horiba SZ-100 is an analytical tool for characterizing the physical properties of small particles through dynamic light scattering (DLS). Depending on the configuration and application the system can be used as a **particle size analyzer**, or also used to measure **zeta potential**, and **molecular weight**. Typical applications for this instrument include nanoparticles, colloids, emulsions, and submicron. suspensions.

Particle diameter	0.3 nm - 8.0 μm
Zeta potential Measurement range	-200 – +200 mV
molecular weight measurement Range	$1 \times 10^3 - 2 \times 10^7$ g/mol

Gel permeation chromatography (GPC)

Gel permeation chromatography (GPC) is a type of size exclusion chromatography, which separates analyses on the basis of size. GPC has become the most widely used technique for analyzing polymer samples in order to determine their **molecular weights** and **weight distributions**.

Company: Yong Lin

Model: YL9100

Solvent: THF

Molecular weight range: **100 - 10^7 g/mol**



Central Laboratory of the Institute

Particle Size Analyzer



The device can be used to determine the particle size distribution in the form of suspensions, emulsions, solids, and aerosols. For particle characterization, both the **size distribution** as well as the **shape parameters** can be identified. The Analysette 22 is the only instrument in the world with which particle size distribution and the particle shape can be analyzed in a single measurement. A prominent feature of this machine is the accurate and repeatable measurements.

Company: FRITSCH

Model: Analysette 22

Measurement range: **0.01 - 2 μm**

Particle Size Analyzer

The Malvern analytical Mastersizer 2000 laser diffraction testing instrument is used to evaluate Particle Size Distribution. Also it can be used for the measurement of emulsions, suspensions and dry powders in the range of **0.02 to 2000 micron**. Particle **size distributions** for both wet and dry dispersions. This method has been used extensively in many industries including color and coating industries, Pharmaceutical, environmental, food, health, beauty and others.



Central Laboratory of the Institute

Scanning Electron Microscope (SEM)



Scanning Electron Microscope (SEM) can easily produce **surface images** over a broad range of magnification (**20X to 50,000X**) from smooth surface, thin layer and fine powders.

Company: LEO

Model: LEO 1455 VP

Atomic-force microscopy (AFM)

Atomic-force microscopy (AFM) or scanning-force microscopy (SFM) is a very high-resolution type of scanning probe microscopy (SPM), with demonstrated resolution on the order of fractions of a nanometer. A scanning probe microscope is an instrument for positioning a sharp tip at a defined distance above the surface of sample. Using an atomic-force microscope (AFM), it is possible to measure **roughness** of a sample surface at a high resolution, to distinguish a sample based on its mechanical properties (for example, hardness and roughness) and, in addition, to perform a micro fabrication of a sample.

Scan range: **1 - 50 μm**

Roughness: **2.7 μm**



Central Laboratory of the Institute

Rheometer



The rheological properties of a sample, such as viscosity or elasticity, can be determined with a rheometer. They can be used in quality assurance, for process designs, product development and research. MCR300 is equipped with different accessories to measure different type of materials. The (MRD) is a special accessory which enables all rheological test types to be carried out simultaneously to the application of the magnetic field.

XENOTEST

The XENOTEST BETA LM is an advanced light exposure and weathering equipment for obtaining vital information about the long term behavior of products when exposed to the influences of weather, and solar radiation in particular, using the time acceleration effect. The optimum conditions for an **accelerated laboratory test** are created by simulating the natural influencing factors and simultaneously intensifying important parameters at sample level.

XENOCHROM 300 (day light)	45-120 W/m²
XENOCHROM 320 (behind window glass)	35-100 W/m²
Test chamber temperature	up to 80°C
Black Standard temperature	up to 130°C
Relative humidity	10 - 95 %



Central Laboratory of the Institute

Thermal mechanical analyzer



Thermal mechanical analysis is a method for studying material deformation as a function of temperature under non-oscillating force. Mechanical thermal analysis tests are usually performed under static forces and different probes are used to measure sample dimensions in compression, permeability, sintering, thermosetting, tensile and bending tests. Other measurements are obtainable using other device equipment which include stress relaxation, creep, film and fiber tension properties, flexural properties and dimensional stability.

Company: Perkin
Elmer
Model: Pyris Diamond

Measurement range: **ambient to 1500 °C**

Honors and Awards

1. Achieving the "Women in Science" prize, UNESCO & MSRT, 2017
2. The 4th rank among Iranian research centers according to the International scientific evaluation reference for universities and research institutes (Scimago), 2019
3. Being selected for promoting of five universities and research institutes to international universities' level, MSRT, 2017
4. Achieving the 7th grade in the performance evaluation of laboratory members of strategic technologies laboratory network
- 5.
6. The 11th rank among Middle East's research centers (based on scimago), 2019
7. The 2nd rank among Iran's research institutes in the field of engineering in terms of research indexes
8. Receiving the title of "Elite Researcher" in the field of engineering in the 17th commemoration ceremony of Iran's elite researchers and technologists
9. Praising the printing industry innovator in the 16th national printing industry fair
10. Acknowledgment of two institute's staffs in the strategic technologies laboratory network meeting of managerial members.
11. First rank among all of the research Incubators of Iran at the 9th Nanotechnology Festival
12. Achieving the title of Young Outstanding scientist in field of chemistry engineering by one of faculty member
13. Achieving the title of pioneer of Top 1% of scientists in the world by one of faculty member, Thomson Reuters, 2015
14. Winning the gold medal at the Sweden international invention festival and special prize of Romania's science and research ministry
- 15- Achieving the title of Iran's elite faculty member by two faculty members, 1393,1396
- 16- Receiving the A ranking for three journals of institute" Progress in Color, Colorants and Coatings", "Journal of Color Science and Technology" and "Journal of Studies in Color world "in the journals evaluations, 1393
- 17- First rank of the institute technology incubator units at Nano technology pioneers festival
- 18- Receiving the title of "Best Research and Technology Deputy" at the 12th commemoration festival

Honors and Awards

of Iran's elite researchers and technologists , MSRT, 2011

Norway, Gjøvik University College



France, Haute- Alsace University



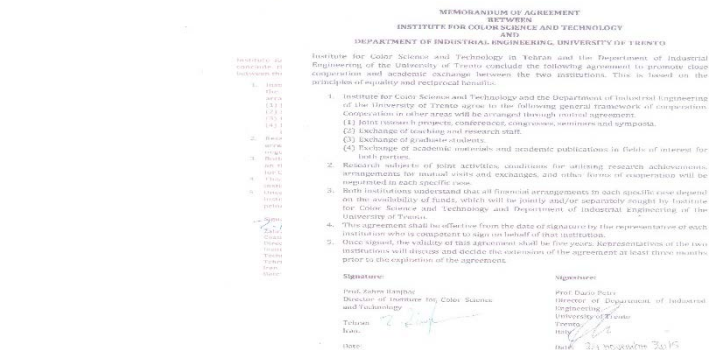
University of Lorraine France,



Germany, University of Stuttgart



England, University of Northampton



Italy, University of Trento



No. 55, Vafamanesh St., Lavizan Exit,



intsco@icrc.ac.ir



+982122976814



+989368109049

