

RISK ASSESSMENT (RiskManager alternative)

Unit/institute:	IMA	Date:	28.02.2021
Responsible line manager (name):	Einar Hjorthol	Revised:	16.06.2021
Responsible for activities being risk assessed (name):	Marita Kyllingstad		
Participants in the risk assessment (names):	Marita Kyllingstad (student), Hilde Lea Lein (main supervisor), Ingrid Hallstensen (co-supervisor), Sidsel Hanetho (co-supervisor), Matilde Skogen Chauton (co-supervisor) and Anh Hoang Dam (co-supervisor)		

Date and signature (student) 28.02.2021 *Marita Kyllingstad*

Date and signature (supervisor) 28.02.2021 *Hilde Lea Lein*

Description of the activity, process, area, etc.:
 The risk assessment belongs to the laboratory work related to the author's master thesis regarding coatings with anti-fouling properties due to the addition of inorganic compounds. Investigation and preparation of epoxy coatings with graphene and graphene oxide additions. The coatings will be spray coated on polyethylene substrates. Characterization of the coating slurries by FTIR and rheometer will be performed. Characterization of the cured coatings by SEM, DSA, profilometer, optical microscopy and fluorescence microscopy will also be performed.

Activity / process	Unwanted incident	Existing risk reducing measures	Probability (P)				Consequence (C)			Risk value (P x C)	Risk reducing measures - suggestions Measures reducing the probability of the unwanted incident happening should be prioritized.	Residual risk after measures being implemented (Px1)
			(1-5)	Health (1-5)	Material values (1-5)	Environment (1-5)	Reputation (1-5)					
Preparation of epoxy sols: mixing epoxy resin DGEBA (100%) and solvents of Acetone (99%) and EtOH (99.97%) as well as epoxy resin Epikote(100%) with Acetone (100%) at 30 °C with constant stirring on a heating plate.	Inhalation or spill of chemicals. Use of glass equipment can cause cuts. DGEBA and Epikote: Can cause allergic skin reaction. Irritates the skin. Cause serious eye irritation. Acetone and EtOH: Flammable and can cause eye irritation. Acetone: Can cause dizziness.	Use protection equipment as gloves, lab coat and protection glasses when handling the chemicals. Work under a fume hood to prevent chemical inhalation.	2	3				5	6	Use parafilm over breakers when transporting Acetone or the sols containing Acetone. Take a break if you feel dizzy.	3	
Preparation of graphene (GO) and graphene (G) slurries based on epoxy sols diluted with Ethanol and Acetone and Acetone respectively (with curing agent PPGBAE added just before coating deposition).	Spill of chemicals. GO: not classified as hazardous chemical. Reduced GO is electrically conductive. Nanomaterial. G: electrically conductive. Not classified as hazardous. Nanopowder. PPGBAE: Cause serious etching damages if in contact with skin or eyes, hazardous to aquatic life.	Use protection equipment as gloves, lab coat and protection glasses when handling the chemicals. Work under a fume hood to prevent chemical inhalation.	2	3					6	Take a break if you are tired to reduce risk of spilling chemicals. Avoid contact with open fire when using TEOS or EtOH.	3	
Characterization of epoxy sols, GO paste, G slurries and GO slurries. (Rheometer and FTIR analysis)	Inhalation or spill of chemicals. Use of glass equipment can cause cuts.	Use of proper protection equipment like lab coat and glasses. Use gloves when handling the chemicals. Work in fume hood to prevent chemical inhalation. Proper instrument training prior to measurement.	2	3					6	Take a break if you are tired to reduce risk of spilling chemicals. Avoid contact with open fire.	3	
Sonication of epoxy slurries with additions of GO or G as well as substrates in EtOH prior to coating.	High energy is involved. Heat evolution may occur. Inhalation of sol. Flammable cleaning liquids.	Practice standard lab routines (use of lab coat and glasses). Stay away from instrument while not in use. Avoid spilling of chemicals. Work under fume hood to avoid inhalation. Avoid chemical inhalation.	2	2					4	Take a break if getting a headache during sonication or feeling dizzy due to inhalation of acetone.	2	
Spray coat PE substrates with prepared sols and slurries containing GO or G. Nitrogen gas used as carrier gas.	Spill or inhalation of sol. Nitrogen gas: Can explode upon heating.	Practice standard lab routines (use of lab coat and glasses). Use suitable gloves and mask. Work in fume hood. Avoid heating due to danger of explosion of nitrogen gas.	2	3					6	Secure properly closed gas ventilations when not in use. Open gas valve carefully.	3	
Removal of excess solvent by heat treating the coated substrates at 60 degree celsius for 4 hours.	Burns due to touching heated substrates or other heated surfaces close to the oven.	Careful handling of the substrates after heating.	1	2					2		2	
SEM analysis of coated samples and un-coated substrates. Sputter coating layers of carbon and gold onto coated substrates.	Inhalation of nanopowder. SEM: ionising radiation exposure, electrical hazards and ergonomic issues. Sputter coaters: danger of crushing fingers when opening/closing instrument.	Proper teaching before use of instrument. Ionising radiation exposure: Avoid deconstructing this instrument if you are not given proper training. Ergonomic issues: Take breaks when using the instrument to avoid eyestrain. Adjust the chair to a comfortable position. Work under fume hood when handling nanopowders.	1	4					4	Ask certified technical staff if procedure is unclear or difficulties arise.	4	
Measurements of contact angles and surface free energies using water and 1-bromonaphthalene on coated samples.	Damages if instrument breaks or if user gets cuts from broken instrument. 1-Bromonaphthalene: Acute toxicity (oral), eye irritating.	Proper teaching before use of instrument. Stop measurement if instrument is damaged. Careful not to put hands under instrument when in use. Work under fume hood and use gloves when handling 1-Bromonaphthalene and let samples evaporate under fume hood after analysis.	2	3					6	Ask certified technical staff if procedure is unclear or difficulties arise.	1	
Measurements using fluorescence microscopy, optical microscopy and surface profilometer (Nanolab) of coated substrates.	Damages if instrument breaks or if user gets cuts from broken instrument. Direct UV illumination of skin or eye during fluorescence measurements.	Proper teaching before use of instrument. Stop measurement if instrument is damaged. Careful not to put hands under instrument when in use. Avoid direct contact with the laser in the fluorescence microscopy.	1	3					3	Ask certified technical staff if procedure is unclear or difficulties arise.	1	
Cross sectional analysis of coated substrates. Coated substrates will be submerged into sample holder with epoxy, before ground and polished.	Smashed fingers when removing the sample holder from the sample. Grounding and polishing fingers when using the grounding equipment and polishing equipment. Epoxy coating material: Cause skin and eye irritation. Can result in an allergic skin reaction if in contact with the skin.	Use of proper protection equipment like lab coat and glasses. Use gloves when handling the chemicals. Work in fume hood to prevent chemical inhalation. Be aware of the distance between fingers and polishing/grinding equipment. Careful sample holder removal by using a stamp rather than the hammer to remove it.	2	2					4		2	
Biofilmreactor measurements of coated PE-substrates in seawater with algae culture and nutrition medium. Measurements at 15 degree celsius and flow rate of 1 L/min.	Damages if instrument breaks.	Proper teaching before use of instrument.	1	1					1		1	