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Hydrophobic Composite Coatings with Low Ice Adhesion as a Passive Anti-icing System

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MOTIVATION

Crucial for many industry and life aspects is passive anti-icing system production. Adhesion reduction of super-cooled water droplets to the substrate in different weather conditions and thereby ice formation prevention (reduction of ice adhesion to the surface) is the main problem needs to be solved. Technology development of the highly hydrophobic coatings with anti-icing properties preparation process was the aim of this project. Obtained hydrophobic surfaces based on epoxy nanocomposites modified by fluorinated organic agents (FOA) were characterized by high efficiency in different weather conditions. This surfaces don't need electrical energy to efficient work. The proposed research program has strongly application character with defined recipient of developed technology (aerospace and energy industry). Currently used anti-icing systems need electrical energy to work, therefore the project has high commercialization potential.

RESULTS

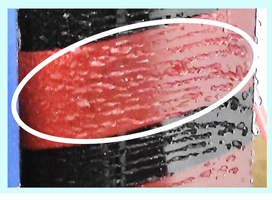
Our anti-icing coating

6-10 kPa

- **High hydrophobicity**
- **Low ice adhesion**
- **No icing under simulated real conditions** (wind tunnel-simulated icing conditions)

Standard paint

160 kPa



About 60% of onshore and offshore wind turbines are affected by icing

↓ effect

Loosing up to 80% of obtained electricity

Additional service costs of a single turbine

Turbine downtime or failure

Fragment of the drone wing with our coatings

Benefits of using our product:

- Protection of wind turbine blades from icing
- Single application and few years of functionality
- Zero electricity consumption
- Lower maintenance costs of wind farms
- Reduction of obtained energy losses up to 80%

Recipient

- **Wind energy industry**
  - Wind turbine maintenance companies
  - Wind turbine manufacturing companies
- **Aviation**
  - Aviation industry companies

Simple application methods:

- spray
- roller
- paint brush

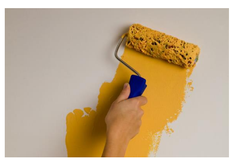
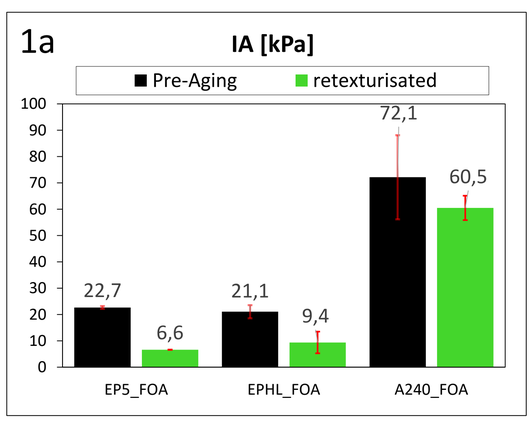


FIGURE 1a, 1b

Ice adhesion (IA) and water contact angle (WCA) comparison of pre-aged and retexturisated samples prepared from different kind of epoxy resins.



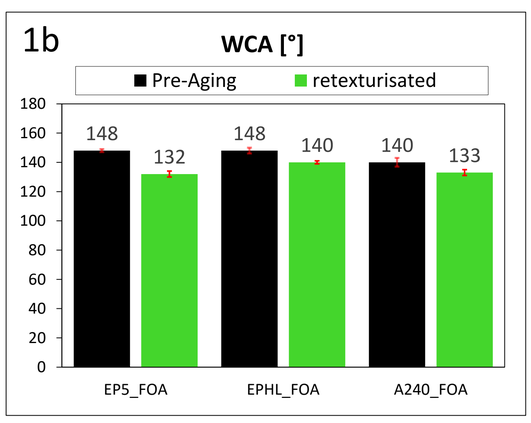
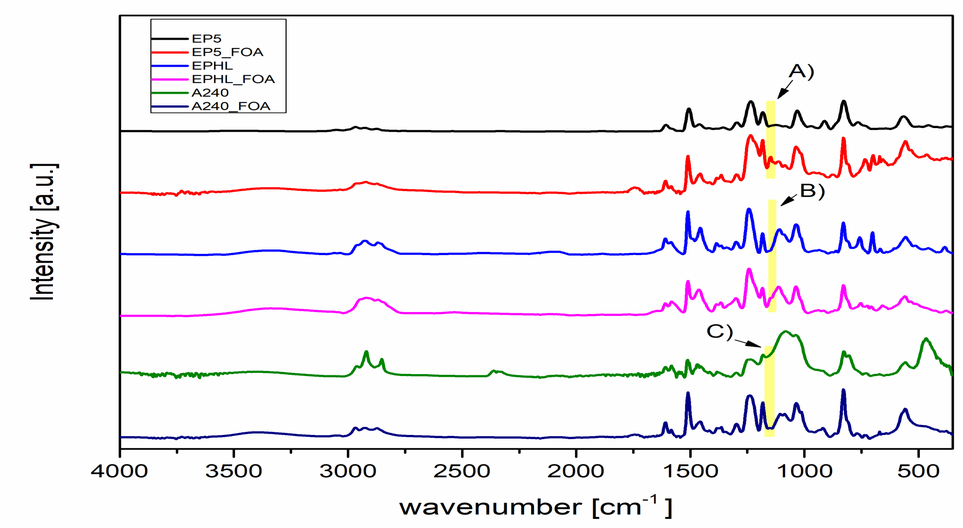


FIGURE 2

FTIR spectra of unmodified and modified samples. In case of unmodified samples: A; B; C; any peaks correspond to wavenumber 1140 cm^{-1} (characteristic peaks for –CF groups) haven't been observed.



CONCLUSIONS

- SFE results shows that FOA is suitable for lowering surface free energy of epoxy based resins.
- FTIR analysis shows that C-F bond around 1140 cm^{-1} is present after modification, it comes from fluorinated modifer proving succesful synthesis.
- After aging and retexturisation functional properties of obtained materials slightly changes, WCA lowers but anti-icing properties are even slightly improved.
- Prepared coatings have anti-icing properties. No ice was observed on sandblasted nanocomposite coatings modified by FOA after tests in aerodynamics tunnel with simulated icing conditions.
- Retexturisation of prepared coatings shows that the anti-icing properties were still observed even after sandblasting.

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