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New, biobased adhesion promoters for UV curing coatings for metal substrate

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INTRODUCTION

UV curing technology is widely used in the furniture, plastic and printing industries. The growing interest in this curing technique is due to its numerous advantages, including low energy consumption, almost zero volatile organic compounds (VOC), fast production speed, etc. The use of UV-cured products on metal substrates is still very limited, despite many advances made in recent years. The main problems are lack of adhesion to the substrate or limited corrosion resistance.

The essence of the research is to develop a new method for obtaining and determining the properties of bio-based, (meth)acrylated, acidic adhesion promoters. Based on the results of the conducted studies, the conditions for the synthesis process were selected, raw materials were selected for obtaining new biobased adhesion promoters and their properties were tested. The assumed structure of the obtained compounds was confirmed, and their basic properties were determined.

Phytic acid (PA)

- 6 phosphate ester groups
- 12 hydroxyl groups → **easy to react**; **good for anticorrosive products**
- bio-based raw material → **ecological product**

Glycidyl methacrylate (GMA)

- presence of a glycidyl group and an unsaturated bond → **possibility of reaction with PA and components of UV-cured products**; **regulation of hydrophilic-hydrophobic properties of PA**

Other components:
catalysts, hydroquinone, solvents (water and organic solvents)

SYNTHESIS

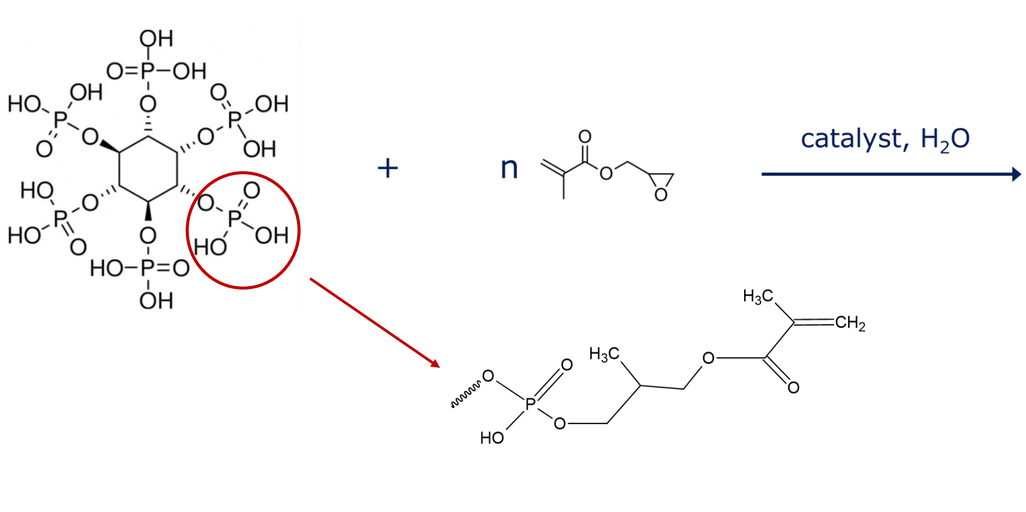


Table 1. Components used for synthesis

No	$n_{PA} : n_{GMA}$	Phytic acid (PA), mol (g)	Glycidyl methacrylate (GMA), mol (g)	Catalyst, % w/w
AP-1	1 : 9	0.01 (6.6)	0.09 (12.8)	Tetraethylammonium bromide 1.0
AP-2	1 : 9	0.01 (6.6)	0.09 (12.8)	Tetrabutylammonium bromide 1.0
AP-3	1 : 9	0.03 (19.8)	0.27 (38.4)	Tetrabutylammonium bromide 1.0
AP-4	1 : 6	0.01 (6.6)	0.06 (8.5)	Tetrabutylammonium bromide 1.0
AP-5	1 : 3	0.01 (6.6)	0.03 (4.3)	Tetrabutylammonium bromide 1.0

CHARACTERISATION OF PRODUCTS

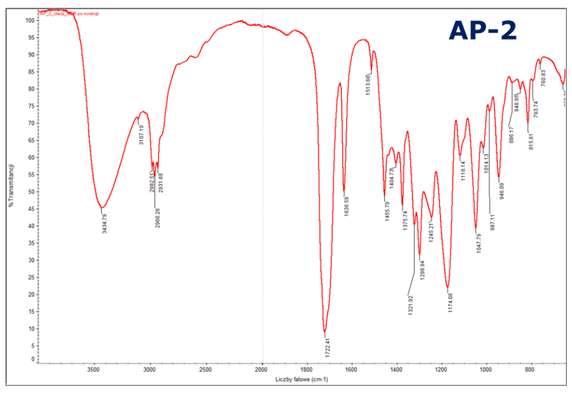


Fig. 1. FTIR spectrum of AP-2

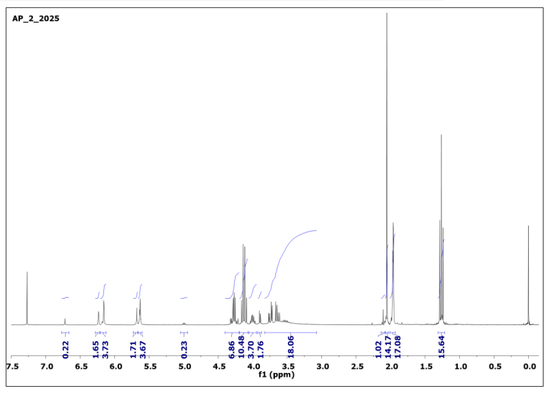
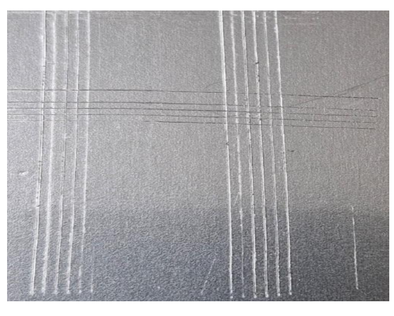


Fig. 2. ^{1}H NMR spectrum of AP-2

Chemical structure of products was confirmed by ^{1}H NMR and FTIR analysis.
In the ^{1}H NMR spectrum, the absorption peaks of acrylate double bond in the range of 5.6 to 6.3 ppm and peaks of methyl group at 1.9 ppm were observed.
In the FTIR spectrum, the bands at 1722 cm^{-1}, 1636 cm^{-1}, 810 cm^{-1} ascribed to the streching vibration peak of carbonyl group, streching vibration peak of saturated C-H, and bending vibration peak of C=C.

The synthesized compounds were used in a model coating composition based on a mixture of a modified oligomer (a derivative of bisphenol A) and an acrylic oligomer based on an amine-modified polyether.



The synthesized compounds were in the form of homogeneous, transparent liquids. They were characterized by very good compatibility with other paint components. They improved the adhesion of coatings to a steel substrate.

Table 2. Properties of coating

Properties	Method of determination	Value
Appearance of the coating	-	homogeneous, transparent
Adhesion to substrate, degree	EN ISO 2409:2021-03	0
Cross-linking of the coating	confirmed by FTIR and DSC	

SUMMARY

A method for obtaining new adhesion protomers based on phytic acid was developed. The structure of the obtained products was confirmed and preliminary tests were performed to use them to improve the adhesion of coatings to steel substrates.

ACKNOWLEDGMENTS

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