Nanocomposites of polyaniline and polymethacrylic acid

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Polymer-polymer composites (PPCs) based on electrical conductive polymer – polyaniline (PANI) and polymethacrylic acid (PMAA) have unique properties. Along with the electrical conductivity of the PPC can form films on different surfaces. Such composites can be successfully used for the design of chemosensors, protection of metals from corrosion, etc. Such PPC can be obtained by conducting oxidative polycondensation of aniline with peroxydisulfate of ammonium in the presence of PMAA. But this method does not allow you to control the exact relationship between the components. Another method of obtaining a PPC is a mechanical mixing of PMAA and PANI in a small amount of water and processing the resulting mixture by ultrasonic for 15 minutes. After drying the resulting composites, their physic-chemical properties were investigated.

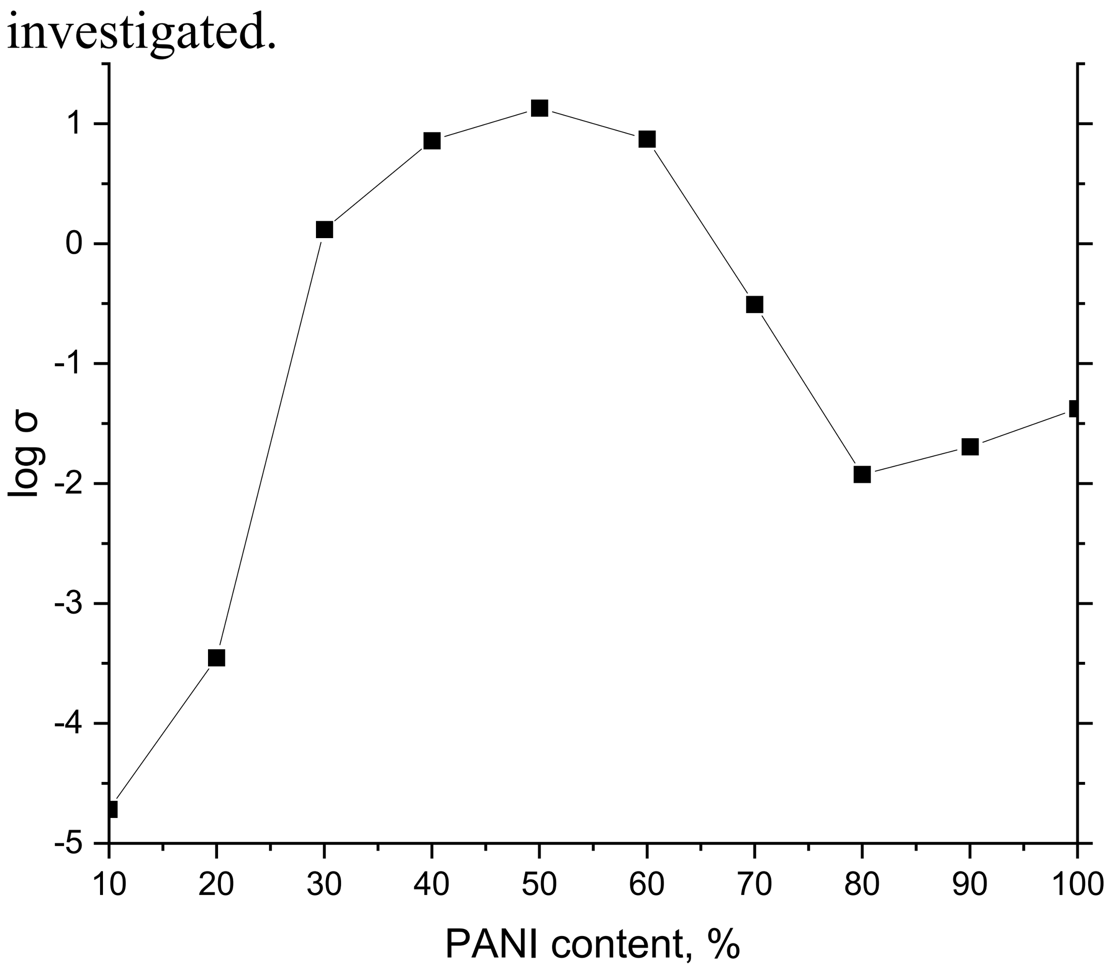


Figure 1. Dependence of the logarithm of the specific electrical conductivity of the composite on the mass concentration of PANI

From the obtained dependence (**Figure 1**) of the specific electrical conductivity of the composite, it can be concluded that the electrical conductivity increases with an increase in the amount of PANI, and the electrical conductivity of the composite with a ratio of PANI to PMAA of 50:50% by mass acquires the greatest value, and then begins to decrease. This indicates the contribution of PMAA in the conductivity of the sample due to the formation of hydrogen bonds between polymers, which contributes to the electrical transfer, as well as the alignment of the framework of PANI molecules along the PMAA.

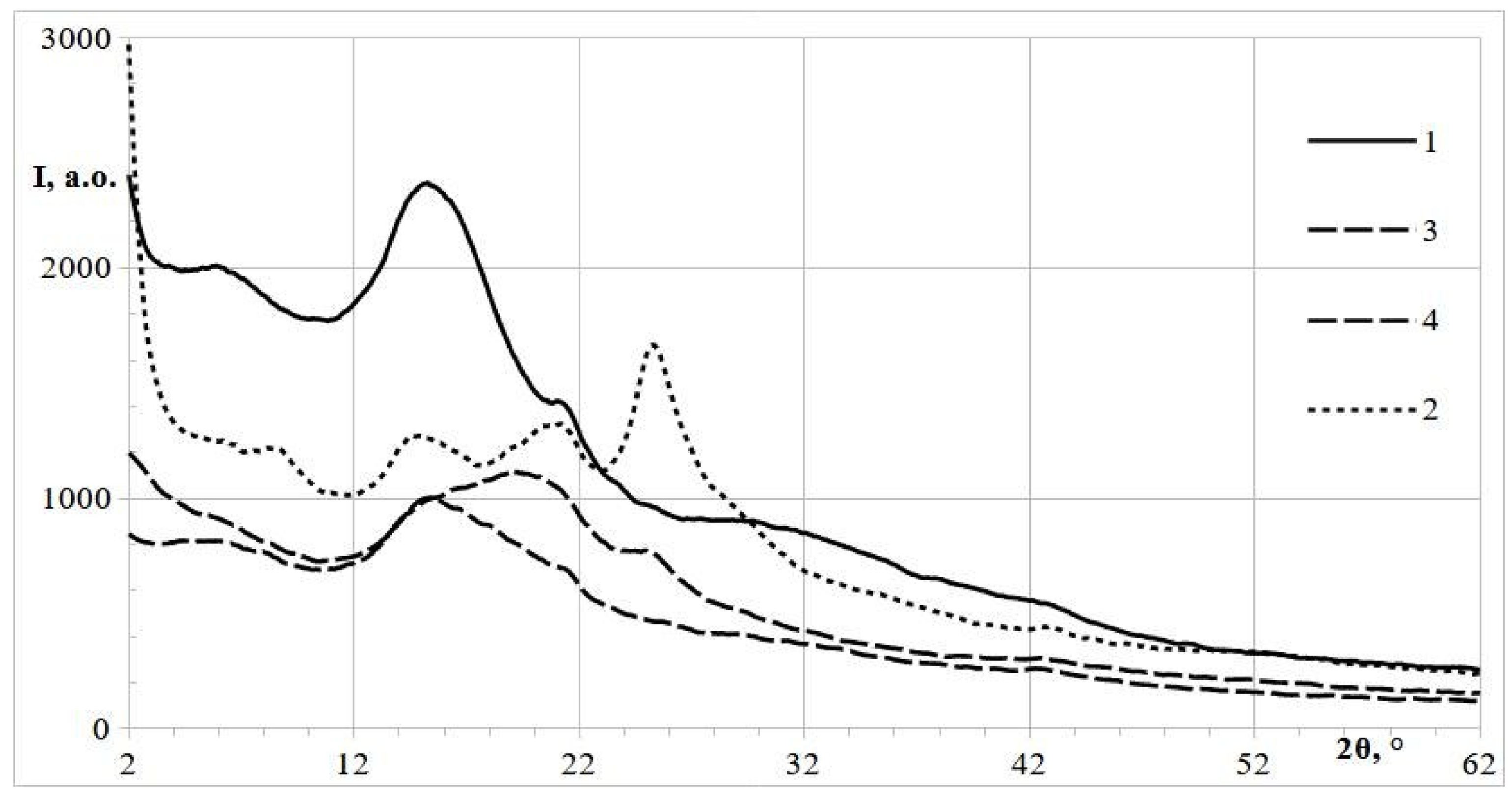


Figure 2. X-ray spectra of PMAA (1), PANI (2) and composites based on them with a content of 20 wt. % PANI (3) and with a content of 70 wt. % PANI (4)

The obtained data (**Figure 2**) indicate that there is an intermolecular interaction between the components of the conductive composite - polymethacrylic acid and the conductive polyaniline polymer. Some of the obtained peaks are shifted compared to the peaks of pure samples. This fact indicates the intermolecular interaction between macromolecules of polymers.

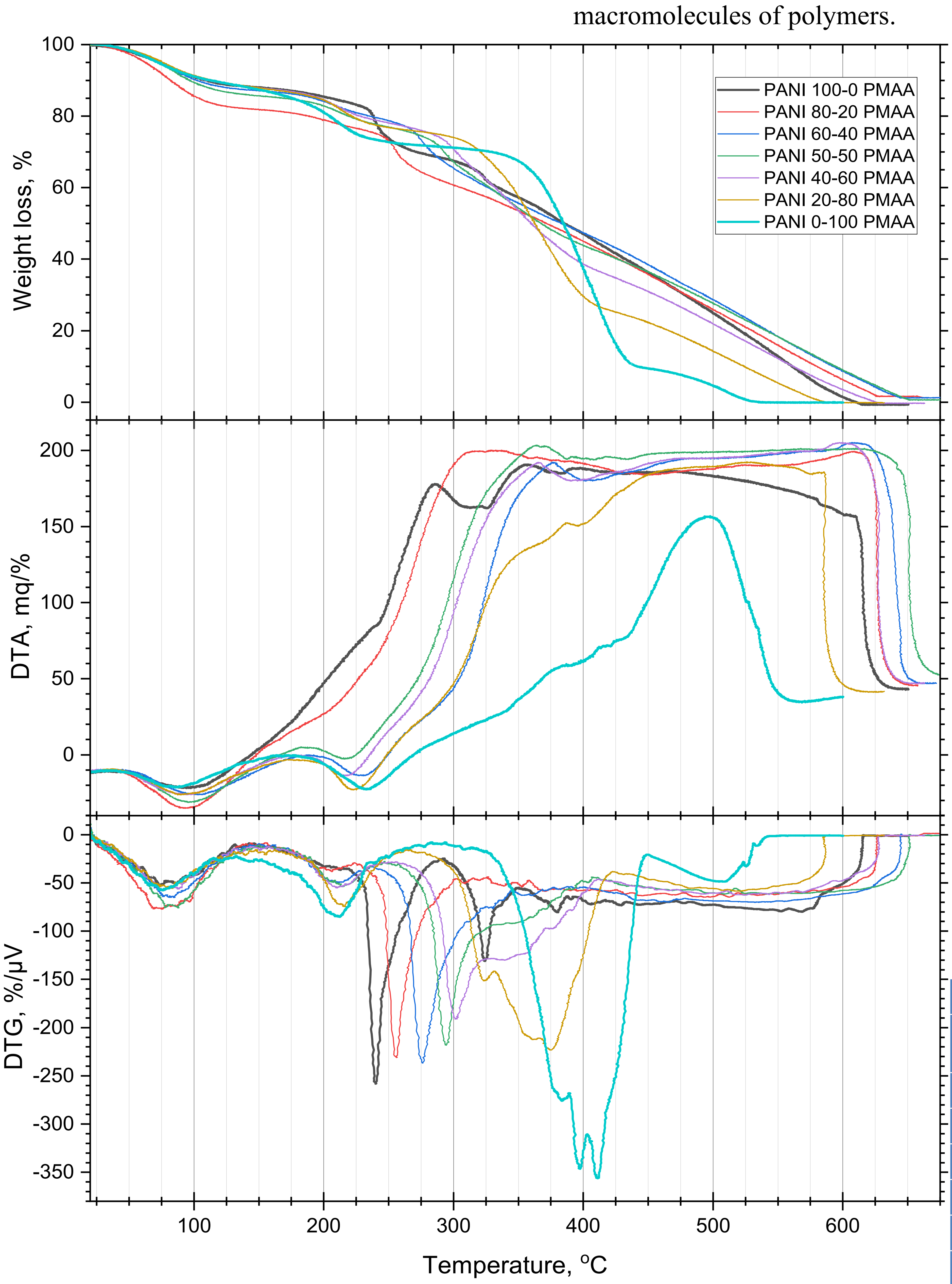
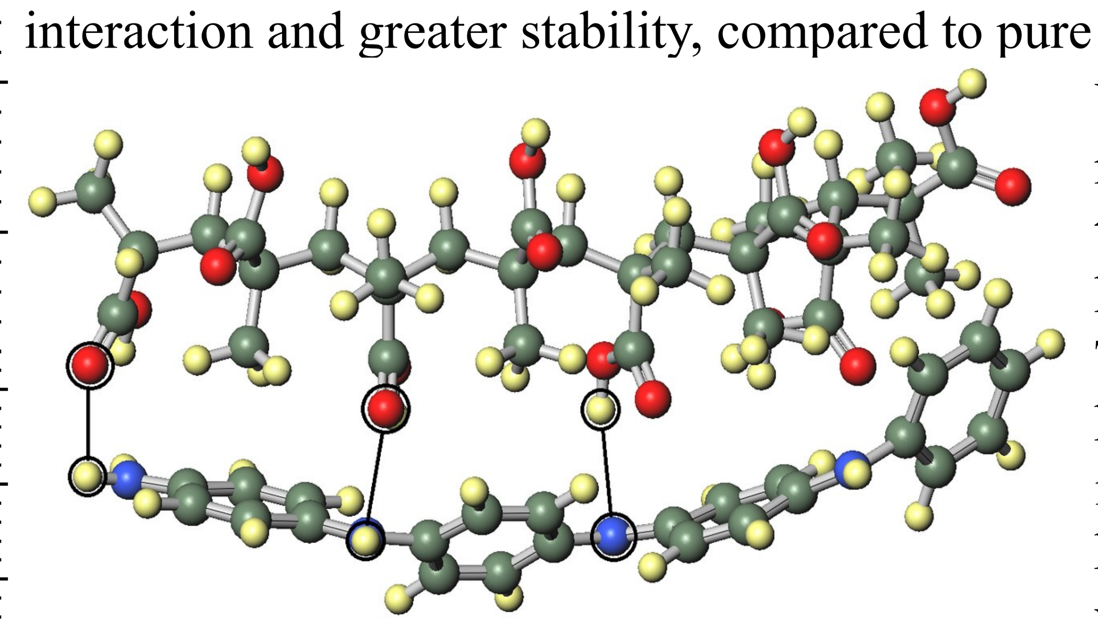


Figure 3. TG-, DTA- and DTG-curves of PANI-PMAA polymer samples in different ratios

The first stage is typical for all samples of polymers and composites in any ratio (**Figure 3**), it corresponds to the loss of the solvent - water, and is in the range of 26 - 130°C. This process corresponds to a loss of 12-14% of mass. The second stage corresponds to the dehydration of PMAA in the range of 170-260°C. During this process, the sample loses up to 11.8% of mass for 100% PMAA and gradually decreases to 5% of mass for PANI-PMAA ratio as 80:20, this peak is absent for pure PANI. The third peak corresponds to the loss of the dopant and is located between 220 and 332°C. Mass loss during this process ranges from 12.2% for 100% PANI to 5.2% for a sample with a ratio of 20:80 - in which the process occurs last. The fourth stage corresponds to the process of complete thermal destruction of composites from 290°C, for pure PANI and composite with a ratio of PANI PMAA as 80:20, for the rest from 300°C. The DTG curve indicates that for samples with PMAA content of 50% by mass and above, the process of dopant loss intersects with the beginning of complete thermal destruction and ends at 640°C.

The DTG and TG curves indicate that the composites had a lower rate of mass loss and the complete decomposition of the composites, with the exception of the sample with a ratio of 20:80 mass of PANI to PMAA, occurred at a temperature of 10°C and more than the decomposition of pure polymers, which indicates on their interaction and greater stability, compared to pure polymers.



Heat of formation, kJ/mol					
T, K	PMAA	PANI	Σ	Composite	Δ
298	-3671,1	1373,6	-2370,1	-2297,5	-72,7
290	-3678,1	1370,5	-2380,3	-2307,6	-72,7
300	-3669,4	1374,4	-2367,6	-2294,9	-72,7
310	-3588,0	1378,5	-2354,5	-2281,9	-72,6
320	-3578,9	1382,7	-2341,0	-2268,4	-72,6
330	-3569,5	1387,1	-2327,18	-2254,67	-72,5

With this conformation of macromolecules (**Figure 4**), the formation of three hydrogen bonds is possible. The average energy of the hydrogen bond, which will be in the range of 22.0 - 25.0 kJ/mol and is close to the values given for the hydrogen bond. The bond lengths are 2.34, 1.71, and 1.55 Å, respectively. It can be argued that the energy of the first bond will be the lowest. The energy of the second bond will accept some average value, and the energy of the third bond will be the highest.

Figure 4. Structural model of PANI-PMAA composite and summarized thermodynamic parameters of the heat of formation of products and composite

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