Plasma as an excellent tool in current chemical engineering

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Plasma is known as the fourth state of matter, similar to the gas phase, where positively charged ions and electrons are separated and move independently. There are two types of plasma, depicted in Figure 1: (i) thermal plasma, where the temperature of electrons and ions is the same, and (ii) non-equilibrium plasma, where electrons exhibit higher temperatures than ions [1]. The latter type is also known as non-thermal or cold plasma. Both types are utilized in current chemical engineering to modify the surface of a variety of materials and to synthesize novel materials, including those of nanometer size. In my research, I apply both types of plasma.

The thermal plasma was used to synthesize graphene-based materials [2,3]. For this purpose, the oxygen-containing compounds were introduced to the argon-helium plasma jet. The results in these two works proved that the presence of oxygen hampers the formation of unwanted amorphous carbon formation. Moreover, the structure of the precursor is of minor importance, the most significant parameter is the oxygen to carbon ratio. Another research related to the thermal plasma covered the synthesis of carbon-encapsulated iron nanoparticles in arc discharge [4]. This material consists of iron nanoparticles covered with the carbon shell, which protects the core from corrosion, oxidation, and agglomeration with parallel remaining the superparamagnetic properties of the iron core. This material can be applied as a magnetic phase of novel adsorbents [5] or catalysts [6].

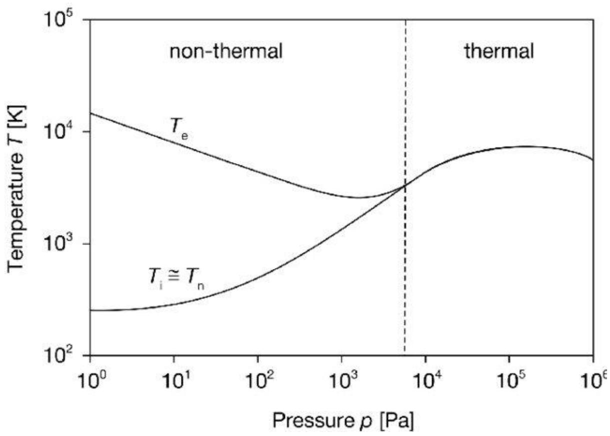

Figure 1. The types of plasma, based on the temperature of electrons and ions [1].

The cold plasma method was applied to synthesize the catalysts for the conversion of carbon dioxide [7,8] and introduce hydrophobicity onto the surface of goose down [9]. In all cases, the application of the cold plasma enabled the deposition of thin layers of materials onto the treated surface. The method of plasma-enhanced chemical vapor deposition was found to be a perfect tool that allows the production of new nanomaterials and the surface modification of conventional materials by the assumed molecular design.

The lecture will summarize the results of my research related to plasma application in chemical engineering. Both types of plasma will be presented and discussed. The presentation will try to convince the audience that the future of chemical engineering is related to the development of methods based on plasma.

Literature

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