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Polymer and Colloid Highlights

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Enzymatic Polymerization in Presence of Vesicles as Templates

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The enzyme horseradish peroxidase polymerizes aromatic monomers like phenol or aniline in the presence of hydrogen peroxide in aqueous solution.[1] Hydrogen peroxide oxidizes the heme group of the peroxidase, which in turn oxidizes the monomers, resulting in the initiation of the polymerization reaction. The resulting polymers have a rather heterogeneous chemical structure with low molar mass and precipitate from the reaction solution. However, if the reaction is carried out in presence of templates, such as appropriate polymers[2,3] or surfactant assemblies,[3] the polymers obtained are more homogeneous in chemical structure and polymer precipitation can be avoided.

In the case of aniline as monomer, polymerization with horseradish peroxidase readily occurs at pH 4.3 in presence of certain negatively charged polymers,[3] micelles,[3,4] or vesicles[5] as templates. Vesicles composed of sodium dodecylbenzenesulfonate (SDBS) and decanoic acid (1:1, molar ratio) have shown to be particularly useful.[6] Although the aniline monomers are initially only loosely bound to the vesicle surface, the polymerization occurs in a controlled way such that the repeating units in the polyaniline chain are mainly linear without significant branching.[6] The presence of characteristic infrared bands for benzenoid and quinoid units and characteristic absorption in the visible and near infrared spectrum of the product obtained (Fig. 1) indicate that the polyaniline formed is mainly the conductive emeraldine salt form.[6] Dodecylbenzenesulfonate is the counterion (dopant, A^- in Fig. 1b) and keeps the polyaniline dispersed in the aqueous solution. The polyaniline–vesicle suspension obtained is very stable and can be used as conductive ink in inkjet printing technology. If the reaction is carried out in the absence of the vesicles, the product obtained is highly branched and non-conductive.

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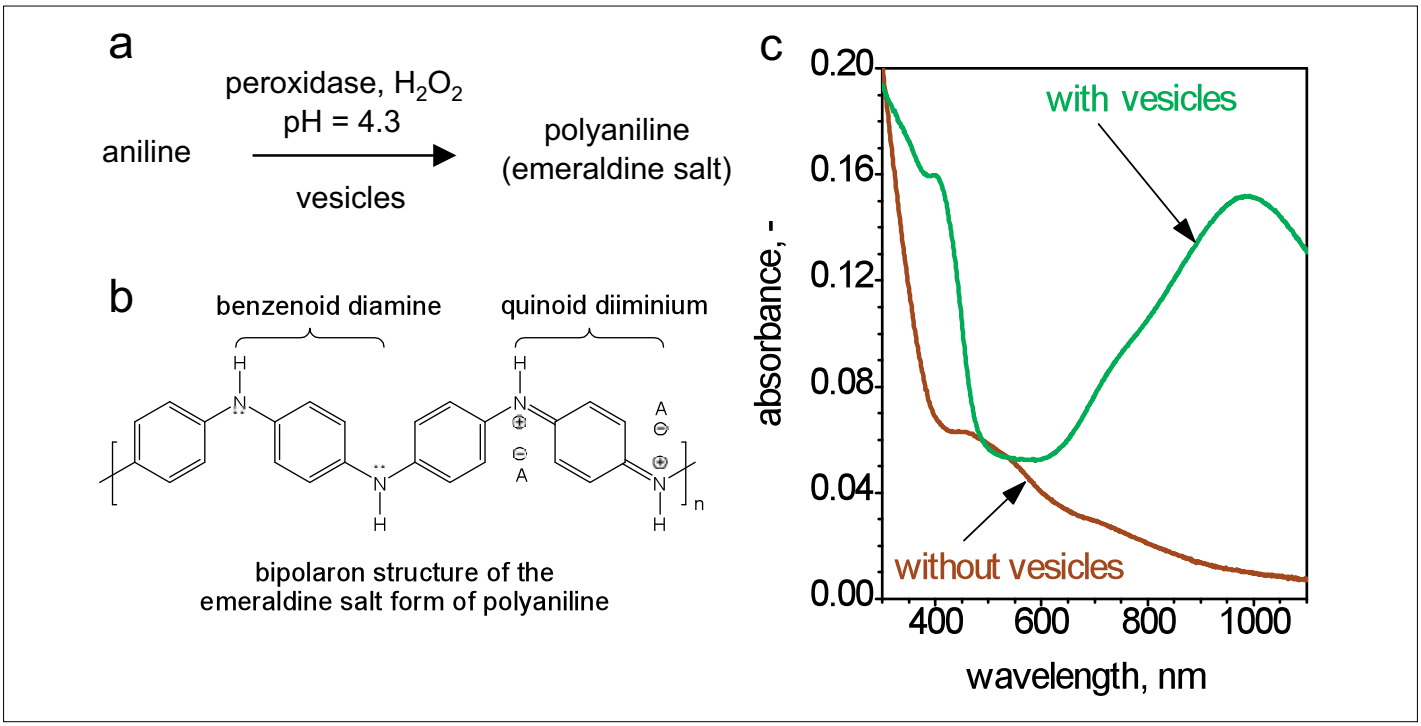

Fig. 1. Peroxidase-catalyzed polymerization of aniline in the presence of vesicles as templates leading to the emeraldine salt form of polyaniline (a, b). VIS/NIR absorption spectrum of polyaniline obtained in the presence and absence of the vesicles, see ref. [6] for details.

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