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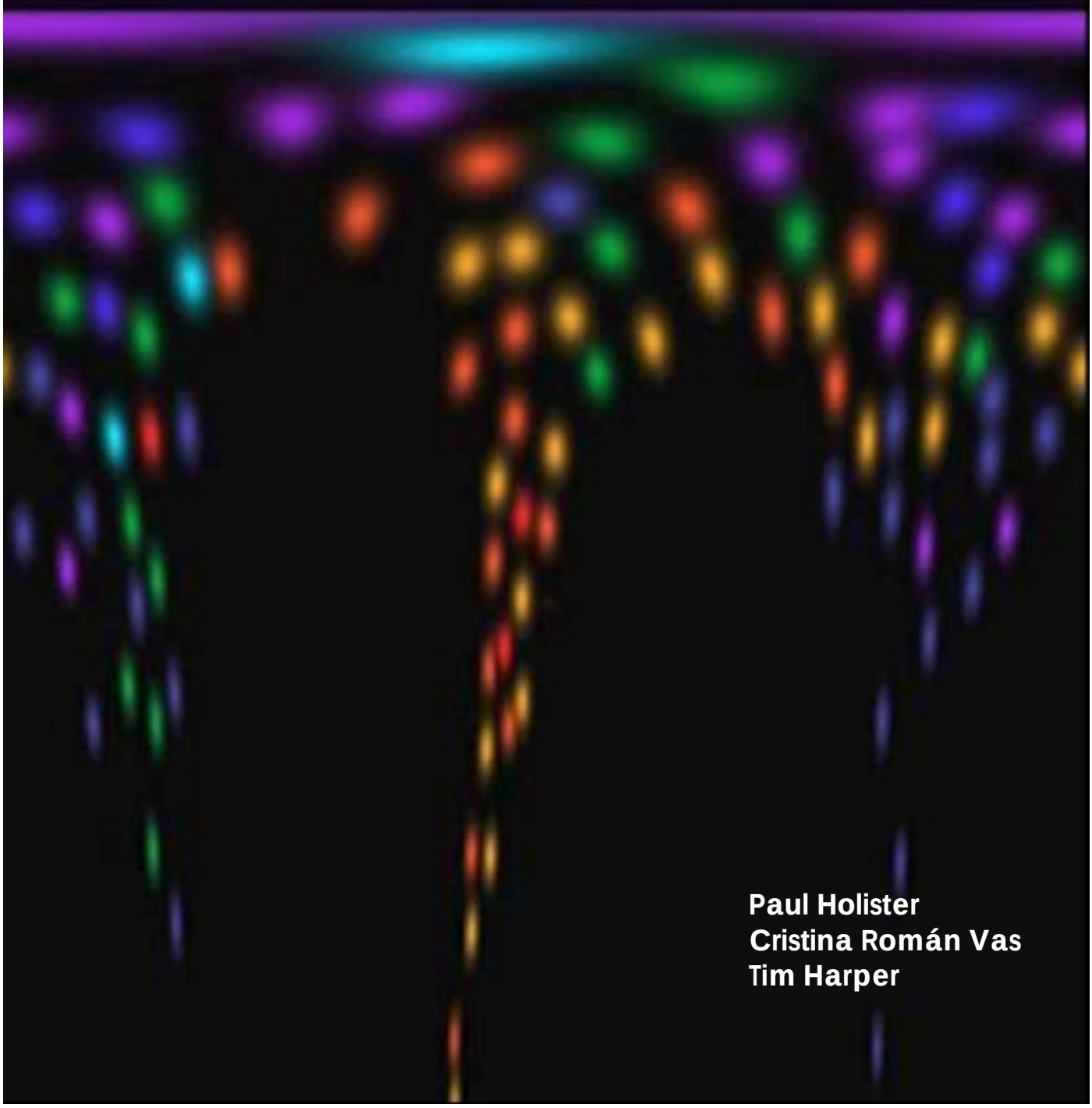

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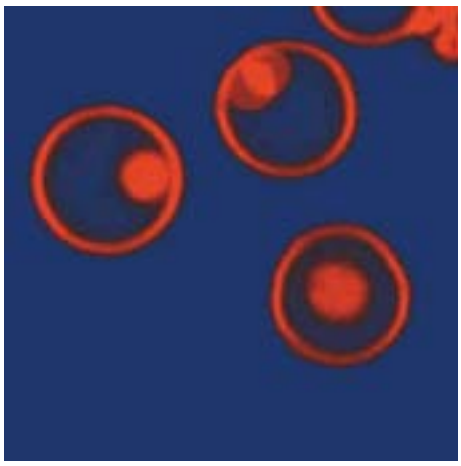
Nanocapsules

The term nanocapsule, as used here, is any nanoparticle that consists of a shell and a 'space', in which desired substances may be placed. We do not use this term, as some have, to refer to coated nanoparticles.

Introduction to nanocapsules



Drug delivery capsules. Courtesy of Capsulation Nanoscience AG.

Nanocapsules have been made for many years, following the example of nature, using molecules called phospholipids, which are hydrophobic (water-repellant) on one end and hydrophilic (water-loving) on the other. When such molecules are placed in an aqueous environment, they can spontaneously form capsules in which the hydrophobic portions are inside, protecting them from contact with water. The walls of our cells are in fact made up of a double layer of such molecules. Inside the cells, similar capsules, called liposomes (literally, fat bodies), are used to transport materials.

Man-made liposomes have been used in cosmetics for some years to control the release of substances or protect them from the environment. Recently many other materials, such as a variety of polymers, have been used to make nanocapsules. The basic process for making the capsules remains generally the same, starting with an emulsion of oil in water or water in oil, creating oily nanocapsules and aqueous nanocapsules respectively. Applications depend on which of the emulsions is used. Intravenous injection of nanocapsules requires a water base and thus nanocapsules made from an oil in water emulsion. However, the nature of the substance to be encapsulated, i.e. whether it is hydrophobic or hydrophilic, also dictates the type of nanocapsule required, and this may not be the same as that required for the desired application. However, coating the capsules with additional layers can get around this conflict. Coating substances can be proteins, polymers and other natural and artificial materials and can be chosen for a variety of properties besides affinity for water or oil, such as adhesion, resistance to different environments, etc. Additionally, temporary capsules can be created (templates) that provide the foundation for building another layer, after which the original capsule can be dissolved away.

Note that the conditions in which nanopcapsules are created are not extreme, in a biological sense, which is one of the reasons they are particularly attractive for the delivery of fragile biological substances.

Polymeric nanocapsules can now be made in specific sizes, shapes, and in reasonable quantities. These can then be "functionalized", by attaching or inserting into the wall substances with a particular property, including that of causing the release of the

contents in response to a particular biomolecule, which would be the triggering mechanism in a targeted drug-delivery system. Polymeric capsules, unlike liposomes and similar capsules, are held together by strong covalent (chemical) bonds, which can make them particularly robust. Many nanocapsules are stable in both liquid and dry forms.

Instead of having a triggering mechanism for drug delivery, the payload can be released by simple diffusion, if the payload molecules were small enough, or the containing structure could degrade naturally or be broken up by ultrasound.

The substances used by viruses to package their nucleic acids are often good models for nanocapsules. Some of these can swell or contract in response to changes in acidity or salinity, offering a way of triggering the release of their contents, which could be put to use in a drug-delivery application.

All in all, a vast variety of substances have already been experimented with in the creation of nanocapsules, which makes the field scientifically interesting and fertile for new applications.

Note that the creation of nanocapsules is a form of self-assembly.