Advanced Integrated Pest Management Via a 3D Microencapsulation Technology

Authors: Miguel Gimeno and Borjana Lubura, Jesmond Bioscience GmbH, Vienna, Austria

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Pest Control News invites specialists in insecticide microencapsulation technology to discuss how these advanced formulations benefit pest management. Our technical editor asks some interesting questions regarding their technology.

What is the main benefit of the latest microencapsulation technology?

It is the controlled release concept of the applied formulation. This further development of pest management strategies coupled with specific active ingredients increases the success rate of insect pest eradication.

How does the controlled release work?

The applied microencapsulation technology in the formulation containing 1R-trans Phenothrin (Figure 1) as the main active ingredient (A.I.) uses one of the latest processes to incorporate a 3D structure providing a fast action and residual effect within one single microcapsule. The process uses three main components in a specific way to release the A.I. The third component acting as a cross linking agent belongs to the Glycoluryl urea family with two butylated groups and a carbonyl group (C=O) that imparts a strong link to the monomer and pre-polymer making the final 3D structure which appears in a sponge form that gives a full control of the release of the A.I. and the mobility modifier.

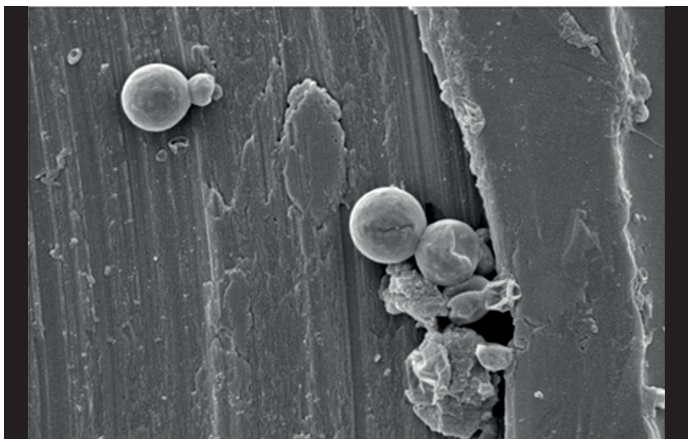

Figure 1: Microcapsules of 1R-trans Phenothrin

How do you achieve the fast acting and long residual effects? (The 'best of both worlds')

The curve of the release rate of the microcapsules is fundamental for the specific mode of action of A.I. that provides a unique fast and long residual activity. It is achieved based on the following features:

- the quantity of the mobility modifier providing the molecular movement from inside the core through the capsule wall;
- the porosity and cross linking of the 3D components;
- the wall thickness that is a function of the percent and rate of the 3D components and the final particle size which is achieved during the emulsion polymerization;
- the protection of the 4th component - acting as the protective colloid which is deposited on the lipophilic surface of the microcapsule covering its pores and avoiding undesirable release before application to the target insect pests creating the so called 4D protection;
- the diffusion through the pores which occurs in a controlled manner in order to achieve the lethal dose specific for the A.I.

What happens as the active ingredients are released?

When the A.I. starts to release through the pores out of the semi-permeable capsules, their tiny droplets cover the pores of the microcapsule wall and since it is not soluble in the water media, the tiny droplets remain covering the pores of the microcapsule wall, thus avoiding the release of further droplets. Only when water starts to evaporate, is when the microcapsules begin to dry out, and small amounts of the A.I. slowly diffuse onto the surface of the capsule.

Once the evaporation stops, the capsules still remain stable for several days covered with the protective colloids used in the final formulation governing the diffusion of the A.I.

How are insects affected by this?

When sprayed, the intact capsules can easily adhere to the lipophilic legs or body of insects when they get in contact with it during walking or resting, which is referred to the so-called "trampling effect". It takes only a few capsules to kill the insect contributing to the improvement in the efficacy. Chewing insects may ingest the microcapsules, receiving a lethal dose.

Just how 'tough' are the microcapsules in the harsh environments of pest management?

Microcapsules can lose their control release prematurely if the pH of the media changes, or the temperature during the shelf life increases and upon application, if exposed to the UV and, last but not least, by the pressure created by the equipment used for the application.

For the microencapsulation process a temperature up to 80°C is required during the curing process before the final stabilization takes place. The components deposited on the microcapsule wall and the two catalysts used during the polymerization provide the required UV protection before the A.I. is released outside the microcapsules.

The integrity of the microcapsules was tested under a high homogenizer pressure supporting no disruption below 160 bars. The microcapsule wall, which is pressure resistant makes the formulation ideal for high pressure spraying, cold and hot fogging *(Tech ed. – remember to follow product labels as not all application methods may be permitted)*.

We're aware that droplet / particle sizes are crucial regarding insecticides. Tell us more about this.

The particle sizes of the microcapsules of 1R-trans Phenothrin are in the range of 1.8 µm (50%) and 10 µm (90%) as the maximum value versus the traditional microcapsules of 12 µm (50%) and 40 µm (90%) as the maximum value.

The microcapsules of the particle size between 1.8 to 10 µm provide a fast controlled release and a long residual activity enabling a full coverage of the surface with a controlled delivery of the A.I. (Figure 2).

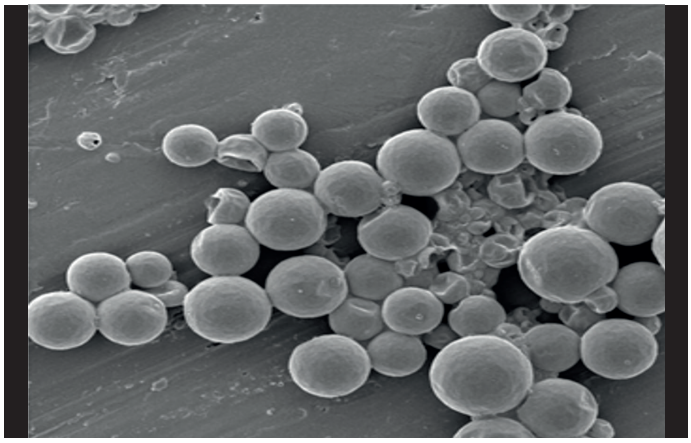

Figure 2: Surface view of the microcapsules 1R-trans Phenothrin

How does your technology compare to other microencapsulation?

The traditional microcapsules available on the market are made of two main components (2D): one monomer and one pre-polymer or one pre-polymer and a cross linking agent, making the structure of the wall of the microcapsules to provide a two-dimensional (2D) control of the release. The release is obtained by a combination of diffusion and osmotic pressure leading to the collapse of the microcapsules. The 2D system cannot achieve a tailor-made controlled release with a molecular diffusion using a specific mobility modifier.

Microcapsules on the market are variable in terms of good quality and performance. Some of them are more resistant to collapse, or to heat, pH and pressure using 2D technologies.

Our 3D technology with the 4D - which is the ideal representation of the components deposited on the surface with an external vision - is the breakthrough of the current microencapsulation technology available on the market.

Can we see some data regarding release rates?

Several studies were conducted to determine and compare the release rate and behavior of the microencapsulated A.I. versus a free, non-encapsulated form (Figure 3).

The results have revealed a clear difference in the release behavior between the two forms.

The non-encapsulated A.I. has shown a fast or immediate and exponential release until exhaustion.

The microencapsulated A.I. has shown an exponential, but slow-release rate over several hours which justifies an increased residual activity applying less quantity, but in a controlled and timely tailored release manner in order to achieve an effective and high killing level in target insect pests.

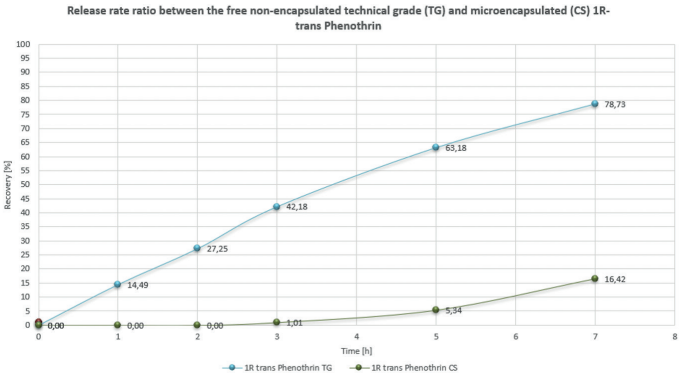

Figure 3: Release rate of 1R-trans Phenothrin

In practice, Jesmond´s technology - including the controlled release rate of active ingredients - has a great potential to overcome the likelihood that an eradication program is downgraded to a long-term pest management as this factor can invoke higher economic and environmental costs.

Thank you to the authors for such an informative article – not all microencapsulated formulations are created equal then! Advancements in formulation technology are the way to go in terms of new developments in insecticides.

Use biocides safely. Always read the label and product information before use.